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Reinforcement of the Pecos River Viaduct: Southern Pacific Ry.

The Pecos River viaduct, crossing the Pecos River in Val Verde county, Texas, is on the Galveston, Harrisburg & San Antonio line of the Southern Pacific Ry. It was built by the Phoenix Bridge Co., in 1892, and was fully described in our issues of Feb. 6, 1892, and Jan. 5 and 19, 1893. For particulars of its recent reinforcement we are indebted to the railway company.

The structure as originally built was 2,180 ft. long and 321 ft. high over the river. Its girders and trusses were spaced 10 ft. apart. The river (about 160 ft. wide) was spanned by two deck cantilevers projecting 52½ ft. from their supporting towers and carrying an 80-ft. suspended span of the lattice girder type between them. The anchor arms were 85¼ ft. long, and the supporting towers had 35 ft. girder spans. The remainder of the structure consisted of a 35-ft. deck plate girder tower spans, with intermediate spans of 35-ft. and 45-ft. deck plate girders and 65-ft. deck lattice girders. All the deck structure was supported on the column caps of the tower bents.

The heavy engine loading of the present day has made it necessary to strengthen this structure. Plans for its reinforcement were made in accordance with the bridge specifications of the Harriman Lines, having a live loading equivalent to Cooper's E-55. For all new material the unit stress formulas in these specifications were used without change, but for old material the numerical coefficients were reduced. The plan finally decided upon for this reinforcement was the use of a line of new girders and trusses through the longitudinal center line, making three lines of girders spaced 5 ft. apart, as shown in Fig. 2.

At the west end, 19 spans (665 ft.) were removed and replaced by an embankment, the track being supported temporarily by falsework. A new concrete abutment was built, 55 ft. high and U-shaped in plan. The front wall is 20 ft. long and the wing walls 17 ft. long on top. The original steel bent supporting the last open span was embedded in the concrete of the front wall of this abutment as a reinforcement. This new abutment may be seen in Fig. 2, with the falsework and old abutment beyond it.

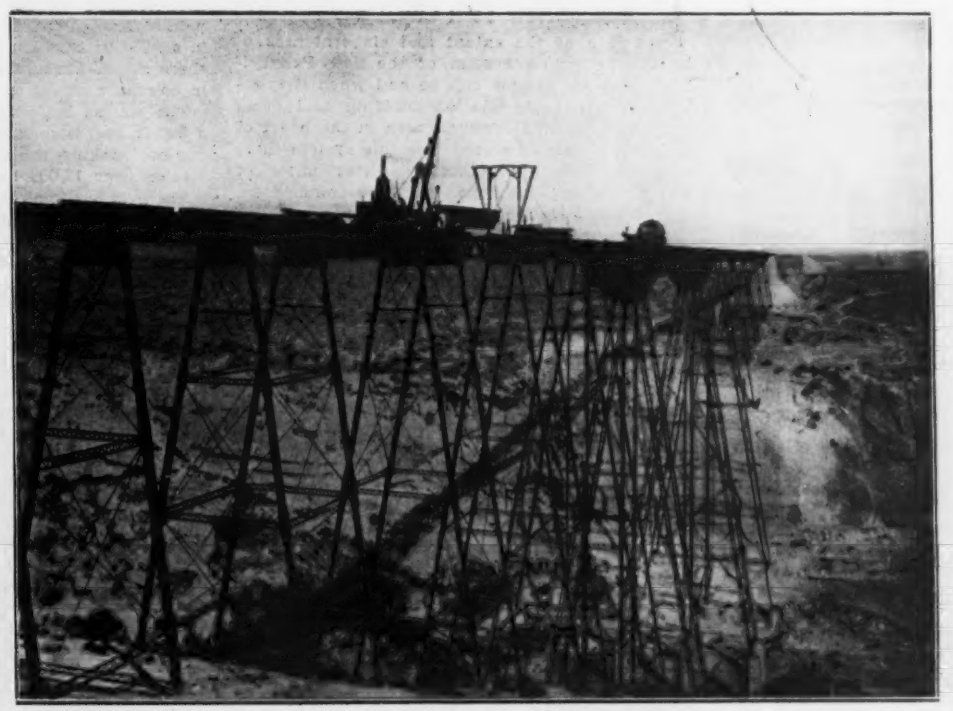
The new center girders are supported upon transverse girders riveted to the tops of the old columns, and these columns were reinforced to carry the additional loading. The new transverse girders were made with a double web section, and straddled the old columns, to which hitch angles had been previously riveted. The old Z-bar columns were reinforced in some cases with four 3½ × 3½-in. angles, field riveted to the back of the web of the Z-bar. In the case of those columns carrying the reaction of a 65-ft. and 35-ft. span it was found necessary to add additional plates 6 ins. wide, shop riveted to the new 3½-in. angles and field riveted to the outstanding leg of the Z-bars, as shown in Fig. 2. At 3-ft. intervals along the length of the column, six-hole batten plates were field riveted to the outstanding legs of the new reinforcing angles, making a very rigid column section.

The new center cantilever trusses and their anchor arms are supported on new center columns. These are provided in the four bents of the two towers of the cantilever spans and in the front bent of each tower at the end of the anchor arms. These columns have a built-up channel section similar to that of the old columns. In order to avoid the necessity of cutting any of the bracing of the towers, the new center columns were shipped bolted up and were erected by straddling all struts and rod intersections. For this reason the lacing bars and batten plates were riveted on in the field. New concrete piers were built to carry the new columns. The main piers are 50 ft. high, 8 ft. square on the top, and about 16 ft. square at the bottom. They are founded upon solid rock.

The new girders for the eight 65-ft. spans of the viaduct have plate webs instead of being of the lattice type as those of the old structure. They are made up of 7/16-in. web plates 83 ins. deep (coped to 48 ins. at each end), flange angles 8 × 6 × 11/16 ins. and three 17-in. cover plates 11/16-in. thick.

The new cantilevers and anchor arm trusses have the same general outline dimensions as the old structure, but are riveted instead of pin-connected trusses. The lateral bracing in the plane of the top and bottom chords is of the usual type, four angles laced together. In place of the single diagonal bracing of 1⅛-in. rods between the vertical posts, a double diagonal bracing of rods was used, straddling the new post as well as the old.

This method simplified the erection to a considerable extent, as the new rods were inserted before the old ones were taken out. As the new post slipped down between the two sets of rods, the lateral stiffness of the trusses was provided for at all times. Except for a short wooden strut at each vertical post no temporary bracing was found necessary during the erection of these trusses, although regular traffic was maintained without interruption. The anchorage at the end of the anchor arm is a built-up link made in



SETTING A NEW 65-FT. PLATE GIRDER BETWEEN TWO OLD 65-FT. DECK TRUSSES; PECOS VIADUCT.

(The derrick car handles one end; at the other end the lines are carried by the gallows frame and led to the locomotive. In the towers at the left are the new transverse double-web plate girders carrying the new central longitudinal girders. At the right are the new and old abutments, and between them the temporary falsework used while removing the old spans and filling in an embankment.)

two parts, one on each side of the new column and connected to the column and the anchor arm by means of 7-in. pins. The adjustment of this anchorage was provided for by making a stub column telescope into the top of the main column. This stub column formed the cap of the main column and contained the pin for the link. When wedged up to its proper position, it was drilled and riveted to the new main column.

The erection of all material was handled from the deck of the bridge by a derrick car of 10-tons capacity. The new column reinforcing metal, in 33-ft. lengths, was swung out over the side by the boom, lowered into place and secured in position with horseshoe clamps. The transverse girders were dropped over the side (one section at a time), swung under the old outside girders and landed upon wedges placed upon shelf angles provided for that purpose. These wedges allowed accurate vertical adjustment of the girder. A diaphragm is field riveted to the center of each section of the transverse girders. All of the short girders, 35 ft. in length and weighing 7½ tons each, were carried out from the shore on the boom end of the derrick car and dropped into place, the deck and old bracing having been removed previously for that purpose. The whole operation required a force of eight men and foreman about 2½ hours.

The 65-ft. girders (18 tons each) were loaded on two flat cars and hauled out to the site by a

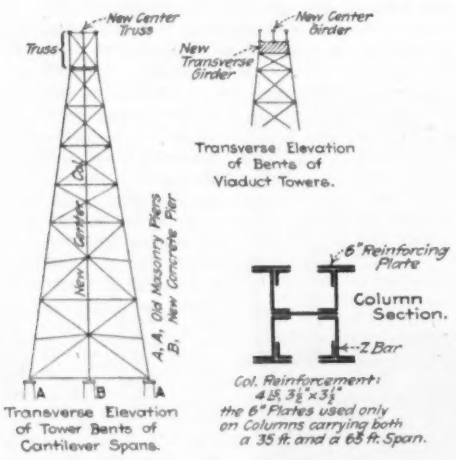


Fig. 2. Arrangement of New Columns, Transverse Girders and Longitudinal Girders for Reinforcing the Pecos River Viaduct for Heavier Loads.

locomotive. A gallows bent of 12 × 12-in. timbers, 17 ft. high and 10 ft. wide, was set up at the west end of the girder. Two sets of falls were handled by means of the locomotive, the leads being fastened to a 12 × 12-in. timber 14 ft. long, bolted to the bottom of a car in such manner that the ends could be used as attachments. To raise the girder, the locomotive with the flat car having the leads attached moved ahead. To drop the girder, the locomotive was backed up. To move the girder either way, one or the other of the leads was slacked off. The opposite end of the girder was handled by the derrick car. The arrangement is shown clearly in the half-tone, and the method of procedure was as follows:

The girder was raised off of the flat cars by the train and derrick car, the two idle cars were then shoved through the gallows bent toward the train and out from under the suspended girder. The girder was then moved laterally until it was about over one rail and the girder end at the derrick car was set upon a wooden frame, while the derrick car removed the rails, ties, and old bracing system; after this the girder was centered and lowered into position. The whole operation of removing the deck and bracing system, setting girder and replacing the deck and new bracing system, took 14 men and foreman about 4½ hours.

The lower chords of the cantilever trusses were placed by lowering each member over the side and swinging it between the web members of the old trusses into the center. Considerable care was required, as these chord sections weighed about seven tons each and had to be swung out 10 ft. from the center line of track in order to clear the 19-ft. ties which carry the sidewalk. The upper chord and web members were erected by removing the deck and dropping them directly into place.

In the 1,100 tons of metal erected there were about 80,000 holes drilled and 135,000 field rivets driven. It required an average of seven air drills and five pneumatic hammers working 9 hours a day for 175 days to complete this work. All drilling and riveting work on the old columns was done from scaffolds. These were made of a 4 × 6-in. needle beam about 44 ft. long, having a cross beam at each end; these beams formed the supports for two working platforms of 2 × 12-in. plank, one at each end. Two gangs of men worked upon the two columns on same side of each tower at the same time. The scaffold rested against the battered side of the columns. These scaffolds made very efficient and stable working platforms.

The design of this reinforcement was made by Mr. J. D. Isaacs, M. Am. Soc. C. E., Consulting Engineer for the Southern Pacific Ry. The shop work was done by the Phoenix Bridge Co. and the erection by the Missouri Valley Bridge & Iron Co. (Mr. W. O. Burkey, Superintendent). The work was under the supervision of Mr. D. K. Colburn, Bridge Engineer for the Galveston, Harrisburg & San Antonio Ry.

Fire Protection of the Pennsylvania Station, New York City.*

Some idea of the extent and elaborateness of the fire protection system of the new Pennsylvania terminal station can be had when it is remembered that the station building and other terminal structures cover an area in the heart of the city of some 28 acres. For this system there were required, approximately, three miles of piping weighing 425 tons, 117 hose connections, 24 roof hydrants and 12 flush hydrants.

In providing for the fire protection of the station, it was necessary to secure a continuous supply of water that would meet all demands for domestic service, and at the same time be able to supply 12 standard fire streams or 3,000 gals. per minute in case of an emergency.

After a study of the variation and uncertainties of the city's distribution system, this end was finally met by tapping the 20-in. main in Seventh Ave. and the 24-in. main in Ninth Ave. and cross-connecting the supply with a private 12-in. main in 31st St. between the two avenues. This would also prevent any appreciable effect on the station supply in event of heavy drafting by fire steamers on one or the other of the two streets. In addition to the connection on 31st St. with the private 12-in. main, there is also a 6-in. connection with the city main.

The connections from the mains are carried directly to two 1,500-gal. Blaké pumps, of the Underwriter pattern, which also have a 16-in. suction pipe leading to two storage tanks of 75,000 gals. capacity. The pumps are located in a building separate from the station itself, which is used for furnishing power for various purposes in the operation of the station. The pumps are cross-connected, and can be operated singly or in battery, and connect with a 12-in. discharge union to the distribution system.

The distribution system consists of two sections or loops; one supplying the sixteen 4-in. standpipes inside the station building, and the other forming a 10-in. "gridiron" loop encircling the track level between Seventh and Ninth Aves. West of Ninth Ave. there is a 5-in. extension connecting back of a 10-in. cross-main with both sides of the main loop and running to Tenth Ave. There are also two 6-in. tie connections near 33d St. and Eighth Ave., between the 10-in. loop supplying the track level and the 6-in. discharge to the stand-pipe system.

The supply pipes throughout are carried in pipe subways, which encircle the entire station area. They are carried on cast-iron hangers from steel girders, and together with the shut-off valves are readily accessible for inspection and repairs. With the exception of a short section of the loop system which is laid underground along 34th St., all the pipe is of wrought steel, and the interior risers of the stand-pipe system are of galvanized steel. The underground sections are of cast-iron pipe of the standard bell and spigott pattern.

Six Siamese hose connections are located on the four street fronts of the building to enable the city fire engines to pump directly into the stand-pipe system should anything happen to the fire pumps at the power station. The pipe runs from the steamer connections are controlled, inside of the building, by independent gate valves, with an automatic check valve in each Siamese connection closing against the building supply.

In the station building are sixteen 4-in. risers, with 83 hose connections. These connections are about 80 ft. apart, and are each supplied with 100 ft. of 2½-in. linen hose, and a smooth tapering nozzle 18 ins. in length and with a 1-in. discharge.

On the track level area there are 23 hose connections on the train platforms, and in the yards west of the station 12 fire hydrants of the flush type. For the platform connections, 100 ft. of 2½-in. linen hose is provided at each; for the yard hydrants hose equipments are stowed in nearby yard buildings, and for the roof hydrants there are two centrally located hose houses with 100 ft. of rubber-lined hose for each connection.

Hand chemical extinguishers are provided in the corridors on the upper floors and at other points throughout the station building; there are in all 75 three-gallon extinguishers. Besides these there are 33 extinguishers of a non-freezing type in column recesses on the track level floor.

The station building is further provided for by a 500-ft. reel hose carriage and a 60-gal. chemical engine; making the total hose equipment of the station over 15,000 lin. ft.

There is a complete fire alarm service with 20 boxes of the non-interfering successive type, wired in loops of ten stations each, and recording on three gongs, located as follows: under the main concourse, in the yardmaster's office and at the station service power plant. City alarm boxes are also located on various parts of the property.

Besides these alarm systems there is an independent one consisting of 116 boxes in the tunnels, which operate gongs in the main powerhouse at Long Island City, in each of the substations and also in the station power-house; so that when necessary the power may be automatically cut off from the third rails in any one or in all the sections.

The fire brigade consists of 25 men divided into three companies as follows: a hose wagon company, a chemical engine company and a stand-pipe company; besides whom there are also five men designated to use the hand extinguishers. Special provision is made for having plumbers and electricians at hand in case of fire, and certain elevator lifts are assigned for transporting apparatus from one floor to another.

While all these measures look to the protection of the station and other property of the Pennsylvania R. R. Co., the buildings themselves, with adjacent structures, form an effectual fire wall across the city from Fifth to Ninth Aves., and would thus materially help in preventing the spread of any general conflagration.

*From information furnished by the Pennsylvania R. R. Co.

INDUSTRIAL TRAINING IN ST. PAUL, MINN., is being given to young men by the St. Paul Institute in cooperation with the "Builders' Exchange," of St. Paul. For two hours in the afternoon of every school-day, instruction is to be given in mechanical drawing, turning and joinery to a class of 100 boys selected from the graded schools of the city by the Superintendent of Schools. The course of instruction is given at the Mechanics' Art High School and has been financed by the "Builders' Exchange" to the extent of $1,200. Evening classes are also to be given, beginning on Oct. 10, for a period of 20 weeks. The course includes two hours of instruction for two evenings each week.

Creosoting Plant of the Pacific Creosoting Co., Eagle Harbor, Washington.

The Pacific Northwest has heretofore been one of the most prolific sources of good timber of this country, but the great use of timber there in the past few years has made a number of timber preservation plants a necessity. One of the largest of these, and possibly the largest plant of its kind in the world, is that recently completed for the Pacific Creosoting Co., at Eagle Harbor, Wash. This plant is located in a well-protected bay, some eight miles west of Seattle, where there is a sufficient depth for any of the Pacific steamers to land. A large dock extends out from the grounds of the company into the bay, and all raw material taken from the ships and the treated material to be loaded on the ships is carried across this dock to and from the plant proper, which is at its shore end. The accompanying illustration gives a general view of the plant looking from the ocean end of the dock toward the treating cylinders and tanks of the plant. The shore is at the immediate right of the tanks in the background of the picture.

The method used in treating timber is a combination of the Full Cell and Absorption processes. The timber is first placed in a closed cylinder, and completely submerged in hot creosote oil which is raised to a boiling temperature by means of steam coils in the bottom of the cylinder. When the amount of condensation shows that enough water has been expelled from the pores of the wood the cylinder is filled up, under pressure, with creosote oil. The filling tank is then thrown out of connection with the cylinder and a measuring tank thrown in and enough pressure is applied to the tank to guarantee the absorption of the required amount of oil. this absorption being measured by the reduction in the gage in the measuring tank. The specifications for this process for three different kinds of wood are given farther along in this description.

The main plant consists of eight treating cylinders, each 6 ft. in diameter, two of them being 115 ft. long, and the other six, 125 ft. The auxiliary plant consists of two large oil pumps for the handling of the creosote oil from the tanks to the cylinders. Three outside-packed duplex plunger pumps for forcing the preservative in the timber, under pressure, are used. There are also two air compressors, one large, compound, two-stage compressor for forcing the liquid from the cylinder after the completion of the charge and one small compressor for operating the saws and tools connected with the plant. The measuring tanks run in connection with the treating cylinders are four in number, each with a capacity of 2,100 gals. The boiler plant consists of three batteries of two boilers each, each battery having a 300-HP. capacity. Of this capacity, 600 HP. is kept in operation all the time and 300 left for reserve. California crude oil is used for fuel. A large underwriter's fire pump is in continuous operation connecting the complete system of fire lines, hydrants, etc.

The creosote oil used in the process is all brought from European ports by the company's own tank steamer, having a carrying capacity of 1,300,000 gals. This steamer berths at the dock and pumps its oil direct to three steel storage tanks having a capacity of 80,000, 450,000 and 1,250,000 gals., respectively. The timber used is mainly Douglas fir, which is the most available wood in this vicinity. It consists mostly of piling, but some railway ties have been treated. In all, the capacity of the plant is about 50,000,000 ft. B. M. per year.

The following are the specifications for the creosoting of the Douglas fir piling in three states, water-soaked, green or freshly cut, and seasoned.

VIEW OF THE DOCK AND PLANT OF THE PACIFIC CREOSOTING PLANT, EAGLE HARBOR, WASH.

Capacity 50,000,000 ft. B. M. per year.
(View is taken from ocean end of dock looking toward the plant at the shore end.)

Specifications for Creosoting Piling at the Pacific Creosoting Co.

WATERSOAKED PILING.

The piling to be treated must be Douglas Fir, thoroughly sound and free from all defects calculated to impair its value. It must be perfectly straight from end to end, free from Teredo, Limnoria or other seaworm holes, also from barnacles and similar attachments. It must be cut from mature stock and show an even taper from butt to point. The butts shall not be less than a full 14 ins. in diameter, nor less than 9 ins. in diameter at the point for lengths of from 50 to 60 ft.

Each cylinder charge must be made up of piles which have been in the water as nearly as possible the same length of time; nor must they have been so long therein as to cause deterioration or damage of any kind.

After the piles are placed in the cylinder they must be immersed in creosote oil of a temperature ranging between 160° and 170° F.; and kept covered during the entire boiling period under at least 4 ins. of oil at the shallowest place.

After filling the cylinder with oil, steam must then be regulated through the heating coils so that the temperature within the cylinder is kept gradually rising as fast as the condensation will permit until 220° F. is reached; after which the steam pressure must only be such as to maintain a regular and constant temperature within the cylinder with 220° as the minimum and 225° F. the maximum, until such time as the amount of condensation per cu. ft. per hr. collecting in the hot well of the condenser shows the interior of the wood to be thoroughly dry, when the steam pressure in the coils should be released, and the cylinder filled up with creosote oil from the storage or working tanks, of a temperature ranging between 160° and 170° F. Then pump pressure should be applied until the gage shows 5 lbs. pressure in the cylinder (this to ensure the fact of the cylinder being actually full) after which the connection between storage tank and cylinder should be closed and the connection between measuring tank and cylinder opened. Additional pressure must then be applied until the piling has taken the proper amount of oil, forced in under such conditions as will ensure its complete retention in the wood after drip is over, and figured at the weight of the dry oil per gallon at 165° F.; the cylinder doors may then be opened provided the temperature within is reduced to below 200° F.

After treatment, the piling must be free from all heat checks, water bursts, and other defects due to inferior treatment which would impair usefulness or durability for the purposes intended. Piles when bored midway between the ends must show no moisture in the center, and the borings beyond the oil penetration must retain their natural elasticity and strength. The penetration of black oil midway between the ends, for a 10-lb. treatment should be at least ¾ in. in piles up to 40 ft. in length; 1 to 1¼ ins. for piles between 40 and 70 ft. in length, and 1¼ to 1½ ins. for piles 70 ft. and over; with a correspondingly greater depth for an increased quantity of oil.

GREEN OR FRESHLY CUT AND SEASONED PILING.

Green, or freshly cut piles delivered at the treating plant on cars, or any which have not been lying in the water and thoroughly seasoned piles must be treated in the manner prescribed.

No piling in these two classes must be mixed together and treated in the same charge, and none in either of these two classes should be treated which is not at the time free from rot, and in proper condition for use after treatment so far as splits or breaks are concerned; if any such is received from the mills it should not be treated unless the inspector directs it to be done.

After the piling is placed in the cylinder, it must be immersed in creosote oil of a temperature ranging between 160° and 170° F. and kept covered during the entire boiling or heating period under at least 4 ins. of oil at the shallowest place; the engineer on duty must from time to time during the boiling, satisfy himself by bleeding the cylinder that such is the case.

In the case of green or freshly cut piling, steam must thereafter be regulated through the heating coils so that the temperature within the cylinder is kept gradually rising as fast as the condensation will permit until 212° F. is reached, with 215° F. as the maximum; after which the steam pressure must only be such as to maintain a regular and constant temperature within the cylinder between these figures, until such time as the amount of condensation per cu. ft. per hr. collecting in the hot well of the condenser shows the interior of the wood to be thoroughly dry, when steam pressure in the coils should be released.

In the case of thoroughly seasoned piling, the temperature of the oil in the cylinder must be allowed to rise slowly and steadily until 190° F. is reached, with 192° F. as the maximum; and kept between these figures until such time (dependent upon the dimensions) as the interior of the wood shall have become sufficiently warmed up to enable it to take the required amount of oil, when the steam pressure in the coils should be released.

The cylinder should then (in each case), be filled up with creosote oil from the storage or working tank, of a temperature ranging between 160° and 170° F., and pressure from the pump applied until the gage shows 5 lbs. pressure in the cylinder (this to ensure the fact of the cylinder being actually full), after which the connection between the storage tank and cylinder should be closed, and the connection between measuring tank and cylinder opened. Additional pressure must then be applied slowly and steadily until the piling has taken the proper amount of oil forced in under such conditions as will ensure its complete retention in the wood after drip is over, and figured at the weight of the dry oil per gallon at 165° F.; the cylinder doors may then be opened provided the temperature within is below 200° F. After treatment the piling must be free from all heat checks, water bursts and other defects due to inferior treatment, which would impair usefulness or durability for the purposes intended. The penetration of black oil midway between the ends of the piles for a 10-lb. treatment should be the same as specified for watersoaked piling.

The plant is under the supervision of Mr. F. D. Beal, to whom we are indebted for the information given above.

A NEW ALPINE RAILWAY has been authorized, according to "The Engineer" of London, to connect Garmish-Partenkirchen, Bavaria, with Innsbruck, in the Austrian Tyrol. The concession has been granted to the "Oesterreische Kredit-anstalt."

Track Reconstruction on the Chicago Street Railways.

The complete reconstruction of the street railway tracks in Chicago was one of the requirements of the new system of municipal regulation and the agreement between the city and the companies, which went into effect about three years ago, and by which the city exercises a strong control over the construction, equipment, operation and financial affairs of the street railways. This system of municipal regulation was described at considerable length in our issue of March 10, 1910. It may be stated briefly, however, that all this supervision is in the hands of a Board of Supervising Engineers, composed of representatives of the city and the railway companies. It is composed at present as follows: Chairman and Chief Engineer, Bion J. Arnold, M. Am. Soc. C. E.; Assistant Chief Engineer (and representative of the city), George Weston, M. Am. Soc. C. E.; Harvey B. Fleming, M. Am. Soc. C. E., Chief Engineer of the Chicago City Ry. Co.; John Z. Murphy, Chief Engineer of the Chicago Railways Co.; and A. L. Drum, Chief Engineer of the Calumet & South Chicago Ry.

The length of street occupied by the street railways aggregates about 320 miles, and under the agreement the companies were required to have a certain amount of work done within a specified time, as described in the article mentioned above. Up to June, 1910, the reconstruction was completed or under way for about 166 miles of streets, or the equivalent of 332 miles of single track.

Types of Track Construction.

In designing the types of track to be used, the aim was to ensure a substantial construction with a permanent base or foundation and a heavy but renewable superstructure, in order to reduce the expenses for maintenance, repair and renewals. The several types of track construction which have been adopted may be described briefly as follows:

TYPE 1. GROOVED GIRDER RAILS ON STEEL TIES EMBEDDED IN CONCRETE.—This is intended for streets having very heavy traffic and has been used for the equivalent of nine miles of single track. Its further use has been discontinued, however, until the results of experience have been observed, preference being given at present to wood tie construction on account of the greater resilience of the latter. In the steel-tie construction the depth of the concrete base is increased longitudinally under each rail and transversely under each tie, which necessitates the excavation of a series of trenches in the subgrade. The tie is a permanent part of the substructure, and is protected against wear by tie-plates.

The steel ties are of the Carnegie or Buehler H-section 14½ lbs. per ft., 4¼ ins. deep, with flanges 4 and 6 ins. wide. The wider flange is uppermost, to give a good bearing for the rail; this is contrary to the practice on steam railways, but as the ties are embedded in concrete there is no possibility of their rocking under the rail. The ties are spaced 4 ft. apart, except that on the old cable lines they are spaced between the cast iron yokes (the lower parts of which are left in place). A flat steel tie-plate is inserted between the tie and the rail, and the plate and tie-flanges are slotted for the fastenings. The attachment of the rail to the tie (shown in Fig. 4), is of the gib and cotter type, and is a modification of the fastening used with some of the earliest types of steel (or iron) ties in Germany. On one side is a gib gripping the rail and tie and held in place by a cotter. On the other side is a gib holding the plate and tie, and secured in the same way. These fastenings alternate, so that the rail is held alternately by the inside and outside of its base. The arrangement of the fastenings also secures the attachment of the plate to the tie independently of the rail fastenings, so that there will be no movement of the plate upon the tie.

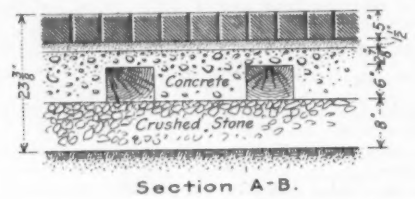
TYPES 2 AND 2-A. GROOVED GIRDER RAILS ON WOODEN TIES EMBEDDED IN CONCRETE (Fig. 1).—This is intended for streets having heavy traffic but where conditions allow of keeping the track closed for a sufficient time to permit the concrete to set properly. It provided originally for ties spaced 4 ft. c. to c., with a concrete beam under each rail, and concrete 6 ins. thick under the ties and 6 ins. under the pavement between the ties. Most of the construction with wooden ties in 1907 was of this type. The excavation of the various trenches for the increased depth of concrete under the rails and ties caused considerable trouble and delay, and with men working over the subgrade it was found impossible to keep the sides of the trenches from caving. Early in 1908, therefore, the design was modified by providing a concrete bed of uniform thickness, and spacing the ties 3 ft. apart. A ridge was left between the tracks. The trench was excavated to a depth of 21⅜ ins. below grade, and the bottom was rolled before laying the concrete. The greater proportion of the reconstructed track is of this modified design, Type 2-A.

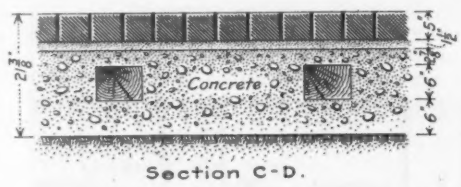
TYPE 3, GROOVED GIRDER RAILS ON WOODEN TIES ON BROKEN STONE BALLAST (Fig. 1).—This construction was designed for the streets in the business district, where the tracks could not be kept out of use for a sufficient length of time to allow a concrete base to set. The trench is of uniform depth, with subgrade 23⅜ ins. below grade, well rolled. The ties are laid 2 ft. c. to c. on a 5-in. or 8-in. bed of broken stone, and concrete is filled between and over the ties, this concrete being 8⅞ ins. thick. This construction is the standard foundation for all track special work, it being considered impracticable to block even a part of a street intersection long enough for a concrete base to become set.

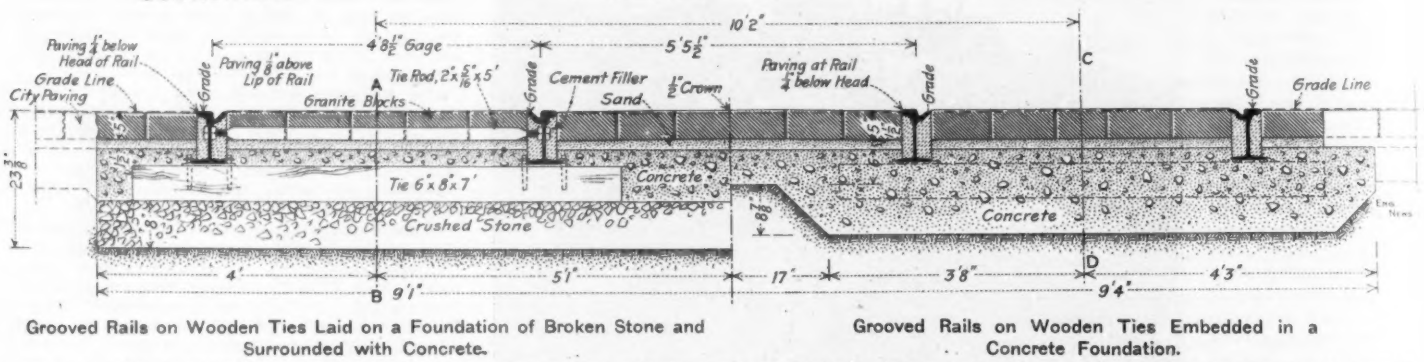
TYPE 4. T-GIRDER RAILS WITH BRICK PAVING (Fig. 2).—This type was designed for use in brick-paved streets in outlying districts. The trench (8 ft. wide for single track and 8 ft. 10¼ ins. for each track in double track) is excavated to 21⅜ ins. below grade and rolled. In this is laid a bed of 6-in. slag, which is covered with fine slag, limestone screenings, cinders rolling mill ashes or foundry sand in such quantities as to fill all voids. This foundation is flooded and rolled with a 10-ton roller to give a finished thickness of 8 ins. After the rails are laid, the concrete is filled between and over the ties, covering the base of the rails. On the concrete is a 1½-in. cushion bed of sand, except that on each side of the rail is 1½-ins. of cement mortar (1:2), being the same as the material used to fill the space under the rail head. This is to prevent settlement of the blocks next to the rail. No nose bricks are used to form a groove or flangeway, but the paving between the rails is laid with a crown such that the end bricks fit under the rail heads, while at the middle the paving is level with the top of the rail. Between the tracks the end bricks are laid level with the top of the rails, while at the middle there is a crown of ½-in. above the rails. An objection to this arrangement is the very broken contour of the street.

TYPE 5. TRAM-HEAD GIRDER RAILS ON WOODEN TIES IN MACADAM. (Fig. 2).—This type is for macadamized streets and highways. A trench is excavated (as for Type 4), and the base well rolled or puddled. A bed of 6-in. slag is laid, covered with screenings, etc., and then flooded and rolled, to a thickness of 8 ins. Upon this are laid the ties to a uniform spacing of 2 ft. c. to c., and slag is filled between them to a depth of 4⅞ ins., after which there is a 4-in. course of 2½-in. limestone as the base for the paving proper.

The macadam has a 4-in. base of 3-in. granite and a ½-in. surface coat of ½-in. granite screenings. The surface is graded so that between the rails of each track the paving is level with the rail tram at the sides and crowned ½-in. between them; between the tracks it is given a crown of ½-in. above the rail heads. There is the same objection as in Type 4, in the irregular or broken contour of the street.







Grooved Rails on Wooden Ties Laid on a Foundation of Broken Stone and Surrounded with Concrete.

Grooved Rails on Wooden Ties Embedded in a Concrete Foundation.

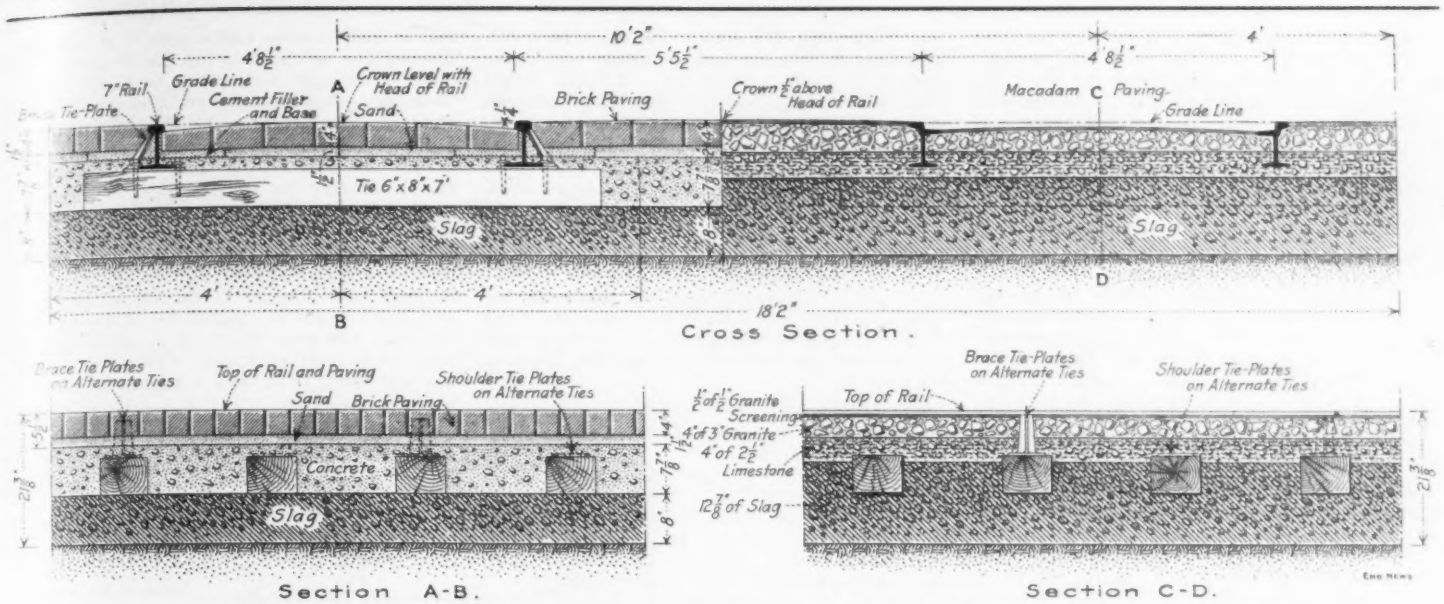
FIG. 1. CROSS-SECTIONS OF STANDARD CONSTRUCTION FOR STREET RAILWAY TRACKS IN THE BUSINESS DISTRICT AND HEAVY TRAFFIC STREETS; CHICAGO.

TYPE 5. TRAM-HEAD GIRDER RAILS ON WOODEN TIES IN MACADAM. (Fig. 2).—This type is for macadamized streets and highways. A trench is excavated (as for Type 4), and the base well rolled or puddled. A bed of 6-in. slag is laid, covered with screenings, etc., and then flooded and rolled, to a thickness of 8 ins. Upon this are laid the ties to a uniform spacing of 2 ft. c. to c., and slag is filled between them to a depth of 4⅞ ins., after which there is a 4-in. course of 2½-in. limestone as the base for the paving proper.

The macadam has a 4-in. base of 3-in. granite and a ½-in. surface coat of ½-in. granite screenings. The surface is graded so that between the rails of each track the paving is level with the rail tram at the sides and crowned ½-in. between them; between the tracks it is given a crown of ½-in. above the rail heads. There is the same objection as in Type 4, in the irregular or broken contour of the street.

Track Material.

RAILS. (Fig. 3).—The rail used exclusively (except at curves) on the lines in the business part of the city is a 9-in. grooved girder rail having a base width of 6 ins. and weighing 129 lbs. per yd. The groove is 1¼-ins. deep, and its outer side or guard has a slope of 47½° from the vertical, so as to make the groove practically self-cleaning, as the wheel flanges can force the dirt outwards. The top of the guard is ¼-in. lower than the head. The outer side of the head is beveled, for the purpose of enabling wheels to ride over it more easily, as the paving is laid



T-Girder Rails with Brick Paving. Step-Head Girder Rails with Macadam Paving.

FIG. 2. CROSS-SECTIONS OF STANDARD CONSTRUCTION FOR STREET RAILWAY TRACK IN OUTLYING DISTRICTS; CHICAGO.

level with the bottom of the slope in order to allow for wear of the rail head. This ¼-in. projection above the pavement is expected also to make the rail head self-cleaning and so maintain a good electrical contact for the wheels. On the other hand, it has been urged that a better pavement would be secured by laying the blocks level with the top of a square-head rail, leaving no ridge or outside channel as with the present construction.

The grooved guard rail for curves is similar to the ordinary rail, but the guard side of the groove is made much heavier; the guard is 1¼ ins. wide on top and rises ⅝-in. above the rail head. For lines in the more thinly populated residence and suburban districts, T-girder rails are used with brick paving and tram-head girder rails with macadam paving. A wear of ⅝-in. on the head is taken as the limit of life to the rail, as this will bring the wheel flange in contact with the bottom of groove or the rail

ft. and 56 ft., with 20% of each order in shorter lengths down to a minimum of 35 ft. The specifications allow a variation in length of ⅜-in. over or under the nominal length for rails over 45 ft., and ¼-in. for rails less than 45 ft.; also a variation of $^{1}/_{64}$-in. under or $^{1}/_{32}$-in. over the specified height, ⅛-in. in width, and a convexity of $^{1}/_{32}$-in. in the base. The requirements as to chemical composition are given below. The guard rails are the same, except that for open-hearth rails the carbon is 0.50 to 0.65% (0.58% preferred), while for Bessemer rails it is 0.45 to 0.50%.

	Open-hearth steel, per cent.	Bessemer steel, per cent.
Carbon	0.60 to 0.75 (0.68 preferred)	0.50 to 0.60 (0.55 preferred)
Sulphur, not over	0.06	0.08
Phosphorus, not over	0.04	0.10
Silicon, not over	0.20 (0.15 desired)	0.20
Manganese	0.60 to 0.90 (0.80 desired)	0.80 to 1.10

RAIL JOINTS.—The rails are laid with suspended and square joints, with the variation from proper position of joints of opposite rails not exceeding 1½ ins. The rails are butted together and spliced temporarily by flat bars

ents and has its own portable plant mounted on cars. Under this process two flat steel bars 1⅛ × 3½ ins., 22 ins. long, are welded to the webs of the rails, welds being made at each end and the middle of the bars. The rails themselves are not welded together. The equipment and methods of work were described in our issue of Sept. 1, 1910.

The first operation is to remove the temporary two-bolt splice bars and clean the surface of the rails by a sand-blast apparatus, which is operated from a car on the track. A portion of the outer edge of one rail head is ground smooth and the number of the joint marked with die punches. Following this car is a pair of cars for the welding apparatus, the front car having the hydraulic press for gripping the splice bars to the rails, while the rear car has a rotary converter which takes 500-volt direct-current from the trolley wire and delivers 300-volt alternating current. This is led to a transformer on the hydraulic grip and a secondary circuit for a current of 5 volts 30,000 amperes is passed from this to the contact jaws. The rails are butted together when laid, but if there should

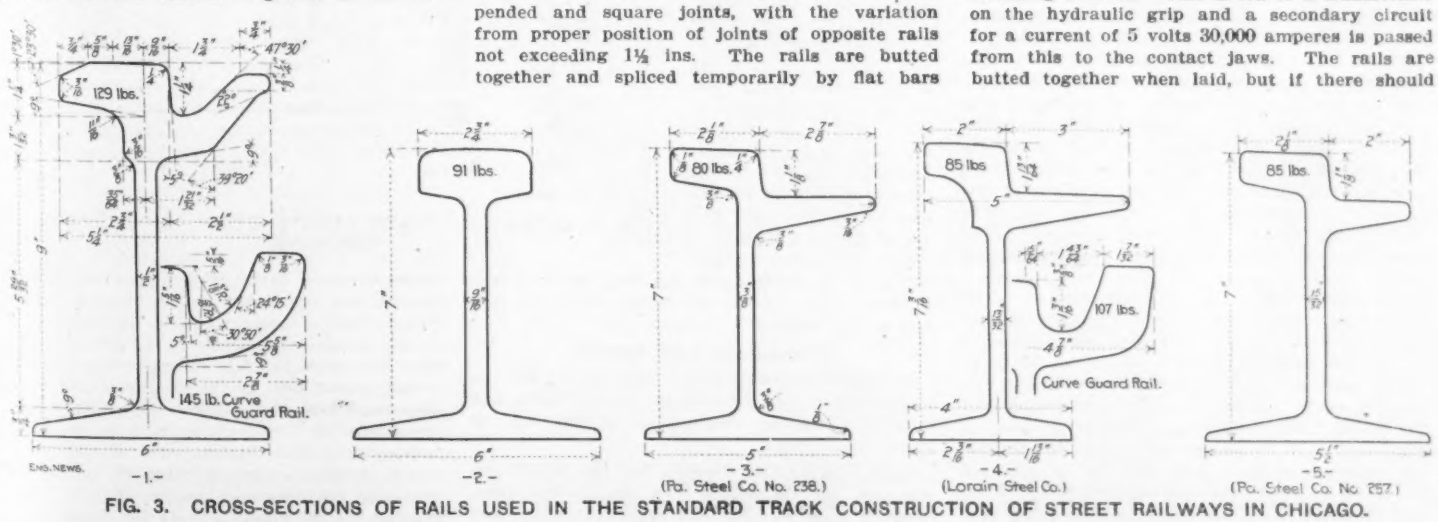


FIG. 3. CROSS-SECTIONS OF RAILS USED IN THE STANDARD TRACK CONSTRUCTION OF STREET RAILWAYS IN CHICAGO.

tram. The dimensions of the rails are shown in the table at the bottom of this page.

The specifications provide for both open-hearth and Bessemer steel but most of the rails are of the former class. The standard length are 58

or fish-plates 16 ins. long, with a 1-in. bolt in each rail. These bolts are near the bottom of the web. On practically all of the work the rails are electrically welded, the work being done by the Lorain Steel Co., which controls the pat-

be an open space at the joint this is filled with a thin steel plate. The bars are set in place, the hydraulic grips are adjusted, and the current is turned on, passing from one jaw of the grip through the bars and rail to the opposite jaw. At the same time the grip presses the bars against the rails. A fluxing composition is added during the process. A temperature of about 2,500° is attained, and the time for making the three welds at each joint is about 15 minutes.

The first weld is made at the joint proper to unite the bars to the ends of the rails; this is made elliptical in shape, with its longer axis vertical. By welding this part first, the bars

RAILS USED IN THE RECONSTRUCTION OF THE STREET RAILWAYS AT CHICAGO.

Rail section.	Grooved girder.	T-girder.	Tram girder.		
Weight, lbs., per yd.	129	91	80	83	85
Height, ins	9	7	7	7	7 3/16
Width of base, ins	6	6	5	5½	4
Width of tread for wheel, ins.	2	2¾	2½	2½	2
Width of head, ins	2¾	2¾	2½	2½	2
Width of groove (at top), ins.	1⅝	....	....	....	....
Thickness of guard, ins	⅝	....	....	....	....
Width of tram, ins	....	....	2⅝	2	3
Total width over head, ins	5¼	2¾ 9/16	5	4¼ 15/32	5
Thickness of web, ins	½	½	⅝	½	23/32
Depth of groove, head or tram, ins.	1⅛	1⅛	1⅛	1⅛	1 23/64

attain their elongation by heat and the end welds are made under this condition. As the bars cool, their contraction tends to draw the rails together. As the rails are embedded in the paving, with only the top of the head exposed, they are regarded as free from changes of temperature (under atmospheric conditions) sufficient to cause any trouble, and as the rails are tightly butted together no account is taken of the rail temperature when welding the joints. The breaks have averaged less than 5% of the number of joints, and nearly all the joints have shown on test a conductivity equal to or even greater than that of the rails. In a majority of cases, the rail ends become slightly arched or convex at the joint, and this convexity is ground off by emery wheels mounted upon a frame attached to a car which follows the welding car.

On some of the outlying tracks and at the connection to special work bolted splices are used. With the 7-in. rails (tram, T or grooved guard rail sections) 26-in. bars are used, with six 1-in. bolts (in 1¼-in. rail holes) spaced 5⅛ ins. for the middle bolts (⅛-in. joint spacing) and 4 ins. for the others. With the 9-in. grooved girder rails, there are 32-in. bars with two rows of six bolts each, the rows being 3 ins. apart vertically. The middle bolts are spaced 5 ins. in the top row and 7 ins. in the bottom row (including ⅛-in. joint space), while the others are spaced 5 ins. apart. The plates for this joint have outside ribs at top and bottom.

The welded rail joints have no electrical bonds other than the welded splice bars, as these are considered to have a conductivity equal to that of the rails. At the connections to special work bond holes are drilled in the rail ends and cored in the manganese-steel castings. A copper cable is laid through the special work for each rail, having its ends welded to the rails. The joints of the special work are bonded independently by 2/0 copper cables.

TIES.—Steel ties are used to a limited extent, as noted above, but wooden ties were considered preferable, as providing sufficient resilience or cushioning to absorb shock and vibration. They are principally of long-leaf and short-leaf yellow pine; but loblolly pine, Norway pine, Oregon fir, cypress or selected red oak, beech and gum are also permitted by the specifications. All are treated by the Burnetising or plain zinc process. The first specifications called for untreated yellow-pine ties, having 90% heart, with the idea that ties encased in concrete would not decay, but on further consideration it appeared that the use of a preservative process was desirable, and would permit of a wider range of soft woods The Burnetising process was adopted as there was no liability of the salts leaching out of ties embedded in concrete, as may be the case with ties in wet ground or exposed to rains. The specifications, however, provide for creosoting also.

The specifications require the treatment to be applied in retorts, with a preliminary steaming (at not over 250° F.), followed by a vacuum of not less than 26 ins. of mercury for 30 to 45 mins., and a final pressure not to exceed 100 lbs. per sq. in. for forcing the zinc solution into the wood. For creosoting, a higher pressure is required. The treatment is required to give an impregnation of ½-lb. pure chloride of zinc per cu. ft. of timber. The ties are 6 × 8 ins., 7 ft. long, bored with $^{7}/_{16}$-in. holes (not over 4½ ins. deep) for the screw spikes.

TIE-PLATES (Fig. 4).—To prevent the rails from cutting into the ties, steel tie-plates are used on every tie. These are 7½ × 9½ ins., with a shoulder to fit the edge of the rail base and so aid in holding the rails to line and gage. A special feature is that each plate is fastened to the tie independently of the rail fastenings. For this purpose there are two holes for 2½-in. fetter drive screws (Fig. 4). The spike holes are U-shaped in plan, so as to take either screw spikes or drive spikes. With step-girder and T-girder rails, alternate ties have the regular shoulder tie-plate and a brace tie-plate which supports the rail heads on the outside, as shown in Fig. 2.

SPIKES AND TIE BARS (Fig. 4).—The standard fastenings are steel screw spikes ½-in. diameter in the shank and having a 2 $^{1}/_{16}$-in. mushroom head which bears directly upon the rail base. These have a ⅛-in. V-thread of ½-in. pitch, as shown. Where drive spikes are used they are $^{9}/_{16}$-in. square and 5½ ins. long under the head, sometimes driven into ½-in. bored holes. There are two spikes to each rail on every tie. To hold the rails to gage, and resist any tilting tendency, tie bars are placed at intervals of 6 ft. (or approximately 4 ft. at rail joints). These are flat bars $^{5}/_{16}$ × 2 ins., which fit between the paving blocks. The ends are 1 in. diameter, passing through 1¼-in. holes in the rail web and secured by nuts on both sides of the web.

SWITCHES AND FROGS.—Each turnout has a single tongue switch on one side and a fixed mate on the opposite side. The construction of switch and mate for the outside track (80 ft. radius) is shown in Figs. 5 and 6. For the inside track (160 ft. radius) the switch angle and mate angle are both 5° instead of 8° and 8½° respectively; the length of switch tongue is 7 ft. 3¾ ins. instead of 5 ft. 2 ins., while the length of each piece is 14 ft. 6 ins. instead of 11 ft. 6 ins. The switch tongue is moved by hand by a switchman or by each motorman, but on the Chicago City Ry. lines it is thrown usually by an electric device. It is pivoted to a large pin in the casting, and has a sliding wedge adjustment for taking up any wear of the bearings or pin. The tongue and the switch and mate castings are all of manganese steel; and the castings are placed upon the regular switch ties. The frogs of the turnouts and of the special work at track intersections are of the solid manganese-steel type, as requiring less work of maintenance and renewal than if made with renewable steel centers. The use of the hard steel is to secure maximum length of life of the parts under the very severe conditions of wear due to the heavy traffic of cars and street vehicles.

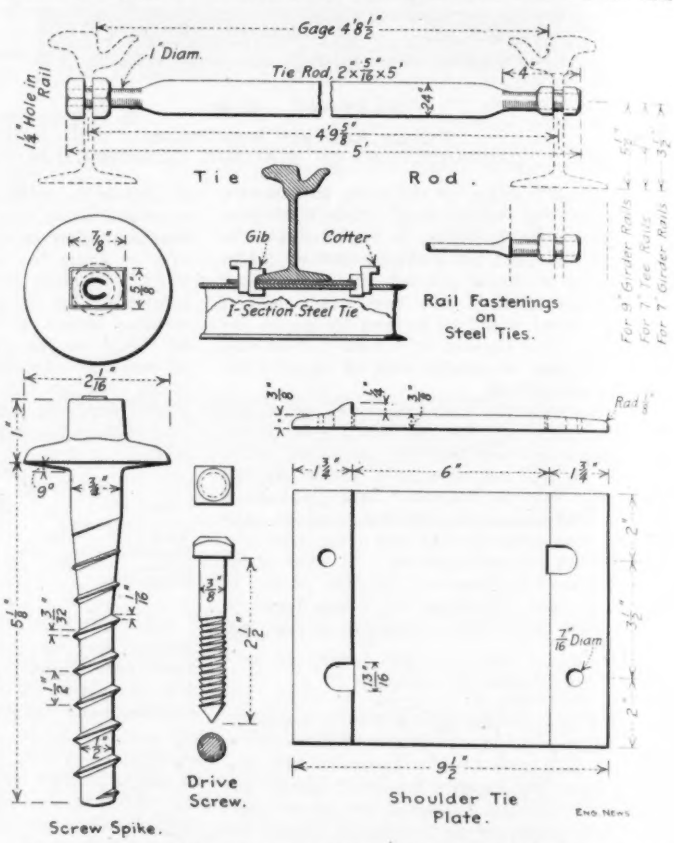


FIG. 4. DETAILS OF TRACK CONSTRUCTION; CHICAGO STREET RAILWAYS.

Foundation and Paving.

BROKEN STONE.—The broken stone for the foundation course is specified to be "hard and durable," screened and free from dirt, and of 1½-in. size.

CONCRETE.—The concrete for the foundation and also for the filling over the broken stone foundation is a 1:3:6 mixture of Portland cement, sharp sand and 1-in. clean screened stone. The concrete covers the base of the rail and is brought to a level 6½ ins. below top of rail, being finished with a sprinkling of dry cement and sand to give a smooth and even surface. In rail renewals, of course, the top of the concrete must be broken up, and the new concrete laid over the rail will be simply a filling material, as it cannot be bonded to or give any strength to the original bed of concrete. There appears to be no difference in the riding of cars on tracks having the broken stone foundation and the concrete foundation.

PAVING.—The street railway companies are required to pave a width of 8 ft. on single track and 16 ft. on double track. Granite block paving is used almost exclusively in the business district and in the outlying districts, but creosoted wood block paving has been laid in some business streets by special arrangement with the property owners. As the construction is designed for 5-in. granite blocks and the wood blocks are only 4 ins. deep, the concrete is raised to bring the bedding sand to the proper level. With grooved rails in double tracks, the outer rails have the top of the heads laid at the required grade, while the inside rails are set ¼-in. above the others by placing the lip of the beveled head (instead of the top of the head) at grade. This is effected by the tamping of the ties. On some of the lines in the outlying districts on the south side, where grooved rails are not used, brick and macadam paving has been employed.

TRACK SPACING.—The spacing of the new tracks was originally made 9 ft. 8½ ins. and as the large cars are 9 ft. wide over all, the clear space between them on tangents was only 8½ ins. It was practically certain that any person caught between cars would be seriously injured if not killed immediately. Considerable objection was made to such an apparently dangerous arrangement, but as the Board of Supervising Engineers held that it was impossible to space the tracks so far apart as to make it safe for persons to stand between cars, it was thought better to adopt a spacing which the public would recognize as dangerous rather than a medium spacing which might be safe for some and not for others. After a considerable amount of the work had been done in this way in the downtown streets a number of accidents occurred, and the Board reconsidered the question of track spacing. In July, 1909, it was decided to increase this to 10 ft. 2 ins. for all new work (giving 14 ins. clearance between cars), the narrow spacing remaining, however, on work already completed.

TRACK GRADE AND STREET GRADE.—One of the difficulties experienced in the paving of streets where the tracks have been rebuilt, especially in the business district, is due to the laying of the new tracks at a higher elevation than the old ones. This elevation was at the grade established by ordinance, which is 14 ft.

above datum (water level in the Chicago River) for street curb and center. The average elevation of the new tracks is 13.7 ft. above datum, and the fact that this is 8 to 12 ins. above the existing street level has been generally assumed by the daily press as a proof that the streets had settled. As stated in our issue of April 21, 1910, however, there appears to be no record as to the exact original elevations and it is considered doubtful whether the streets were built to conform to the established grade. The present condition necessitates a steep slope from the existing gutter grade to the new elevation of the track paving, or else the practical elimination of the gutter. In some cases, where sidewalks are apparently below their proper grade, the center of the street is now higher than the curb. Where curves at street intersections bring the rails close to the curb line (and in many cases these curves have necessitated cutting away the curb corner to accommodate a track spacing allowing the very long cars to pass), there is no room for a gutter, and the paving slopes up from the top of the curb to the rail. Thus in case of rain the water may form pools on the sidewalk. To remedy this condition, the municipal authorities have undertaken a general rectification of sidewalks to the established grade.

CURVES AT STREET INTERSECTIONS.—The large cars of the "prepayment" type now in use in Chicago have a total length of 48 ft. and 49 ft. and a width of 8 ft. 9 ins. and 9 ft. These dimensions necessitated special arrangement of the sharp curves at street intersections, to provide the necessary clearance for the sweep of the ends and the sides of the cars in passing round these curves. The standard arrangement is shown in Fig. 7. This is for the narrow track spacing of 9 ft. 8½ ins. on tangents (mentioned above), and as a matter of fact most of the downtown intersections had been built to the spacing before the revised wider spacing was adopted. The dotted lines show how small the clearance becomes at the ends of the curves, but with this standard construction it is never necessary to stop a car on a curve to avoid fouling a car moving on another line. At some intersections there are four of these double-track curves connecting two double track lines, making a very complicated construction for the special work. The curves, as well as the special work at the intersections are laid on wooden ties supported by a rolled bed of broken stone, with concrete filling between and over them. In several cases the sidewalk corner has had to be cut away to admit of laying the track to the standard curves, as noted above.

Methods of Construction.

The reconstruction of tracks in busy city streets offered a number of difficulties and problems in regard to the car and street traffic, the handling of materials, and the execution of the various stages of the work. On the narrower streets it was sometimes necessary to abandon one or both tracks and divert traffic for a time, but this always resulted in a reduction of the receipts. By far the greater part of the work was done, however, without changes in the routing of cars, thus avoiding confusion and loss of patronage and securing the convenience of passengers. This was effected in the wide streets by laying a temporary track at one side of the street for a stretch of four or five blocks, connected with one of the regular tracks by portable turnouts at each end. Under this system there was practically no interruption of the regular schedules; in fact it was found that cars could make even better time than usual, owing to the track being raised above the street level and free from interference by street traffic (except at intersecting streets).

The temporary track was built with 70-lb. T rails spiked to cross ties laid upon the street continual passage of heavy cars would soon affect this temporary construction, and men were at work all the time attending to the blocking and fastenings.

Assuming this temporary track to be on the east side of the street, northbound traffic would be diverted to it, and the old east track in the middle of the street taken up and rebuilt as described below. This being completed, the southbound traffic would be diverted temporarily to the new northbound track, and the southbound track taken up and rebuilt. When both new tracks were completed, the temporary track was taken up and relaid for another stretch of work. The temporary track was in use at any one location for about two weeks, that being the time required to rebuild the two permanent tracks (each as a single track). The progress on one track averaged about half a mile per week.

The temporary track arrangement of course caused some inconvenience to the occupants of buildings in the handling of freight, etc. In some cases coal had to be dumped in the nearest

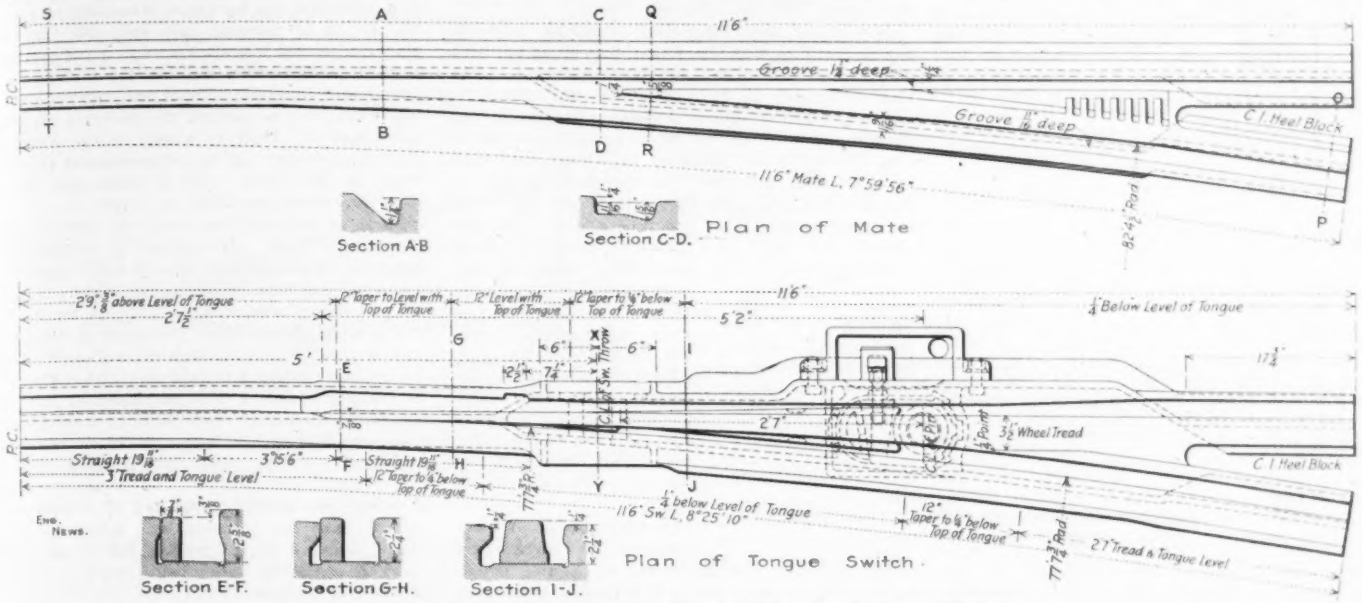


FIG. 5. TONGUE AND MATE FOR SWITCH IN PAVED STREETS.

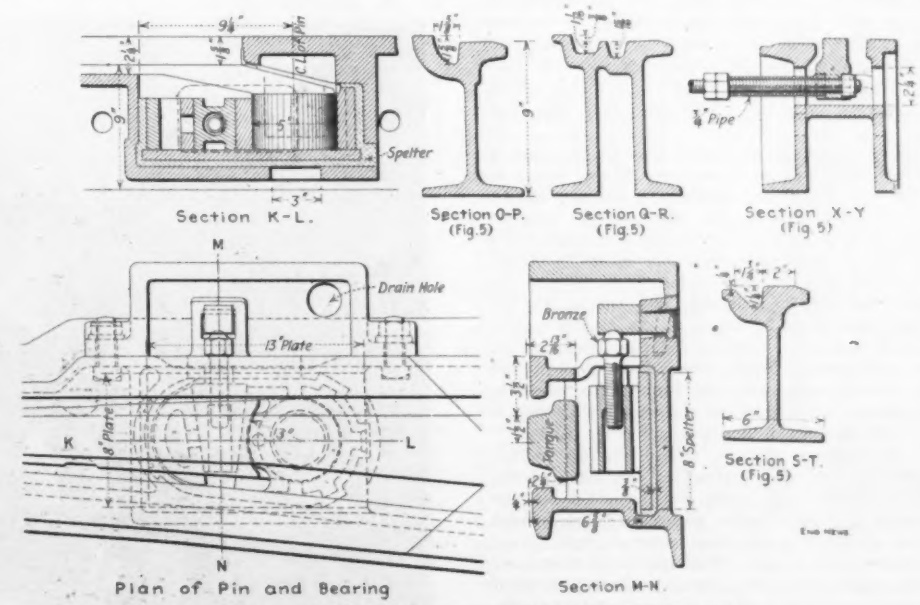


FIG. 6. DETAILS OF SWITCH TONGUE AND MATE.

paving, longitudinal planks with blocking and shims being placed under the ties to bring them to a level. The track was laid as close to the curb line as practicable, and at street intersections planks were spiked to the ties to form a crossing for vehicles. At points where the cars stopped, planks were laid on the ties between the rail and curb. The vibration due to the cross street and wheeled to the building, ashes being removed in the same way. Packing cases, hotel baggage, etc., also had to be trucked to some convenient point. In some cases, the opposite side of the street was closed to vehicles, especially during the reconstruction of the southbound track, in consequence of the storage and handling of material. These inconveniences,

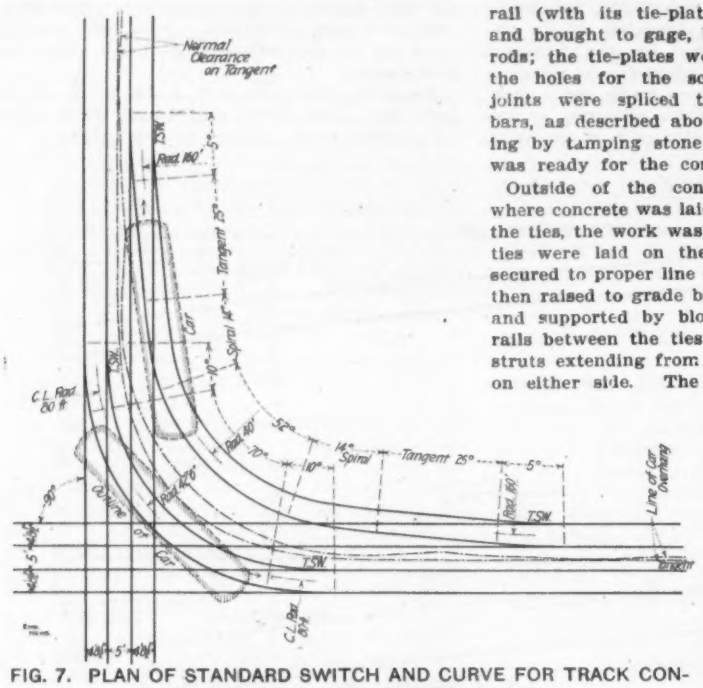


FIG. 7. PLAN OF STANDARD SWITCH AND CURVE FOR TRACK CONNECTIONS AT STREET INTERSECTIONS.

however, were far more than balanced by the convenience to the general public in maintaining the car routes unaltered, to say nothing of the revenue saved by the companies.

The general progress of the work was as described herewith, but it was varied in detail to meet special conditions at different points. The stone paving blocks of the one track abandoned were loosened and taken up, being stacked temporarily upon the edge of the sidewalk or loaded directly into wagons or upon flat cars. Where the old tracks had cast-welded joints the rails were cut with hack saws. They were then raised by screw and ratchet jacks, bringing the ties with them. While supported on rough blocking the ties were knocked off with sledges, this being quicker than to pull the spikes. The rails were then hauled out to the side of the track by teams, and loaded by hand upon timber wagons. The new rails (58 ft. long) were brought upon the work in the same way and distributed in the gutter. The ties were delivered in wagons and stacked along the curb. On the work done by the Chicago City Ry., the rails and ties were hauled to the street on steel-frame motor-driven construction cars built especially for the purpose.

The track space was then broken up with a grading plow, and excavated by shovel gangs to the proper depth and width for the sub-grade. The material was loaded into dump wagons standing in the excavation, snatch teams being employed to help haul them out upon the street. The width was usually about 9 ft. (from the center line between tracks) and the depth approximately 20 to 24 ins. In the middle of the track a trench was made for the electric conduits (of vitrified clay), which were laid in and covered with concrete, the top of the concrete being about 2 ft. below the subgrade. This trench was then backfilled, and the subgrade rolled.

In the business district, where a stone ballast foundation was used instead of concrete (as described already) the stone was hauled upon the subgrade in dump wagons, and after being leveled to the required depth was covered with stone screenings and rolled. The ties were then carried by hand and laid upon the ballast, one steel tie-plate (on the line side of the tie) being sometimes nailed in place beforehand, and sometimes applied after the ties were laid. The rails were next laid, lined in place, and the holes for screw spikes bored with electric augers. The spikes were also screwed home with electrically driven socket wrenches. Current for these machines was taken by a wire attached to a pole and hooked over the trolley wire. The inside or line rail was first secured in place. The outer rail (with its tie-plates loose) was then lined and brought to gage, being adjusted by the tie-rods; the tie-plates were nailed in position and the holes for the screw spikes bored. The joints were spliced temporarily with two-bolt bars, as described above. After a final surfacing by tamping stone under the ties the track was ready for the concrete filling.

Outside of the congested business district, where concrete was laid under as well as between the ties, the work was somewhat different. The ties were laid on the subgrade, and the rails secured to proper line and gage. The track was then raised to grade by ratchet and screw jacks, and supported by blocking built up under the rails between the ties. It was held to line by struts extending from the rails to the pavement on either side. The concrete mixing car was then run over the track, depositing concrete between and outside of the rails so as to form a solid mass about 14⅞ ins. thick above the subgrade and completely covering the ties. The blocking was removed directly behind the car and ahead of the concrete delivery chute.

In both styles of construction the concrete was mixed on machines traveling upon the track. Some of them were motor flat cars, others were short cars equipped only with the mixer and charging bucket with their motor operated machinery, old "bobtail" passenger cars being utilized as motor construction cars to haul the mixing plant. Most of the mixers were of the drum type (½-cu. yd. capacity) and the charge was delivered by wheelbarrows from material piles delivered along the side of the street. In some cases the wheelbarrow loads were dropped into a steel bucket which was raised and swung over to the mixer by a crane on the car. In other cases, however, a charging bucket operated by a cable and moving in vertical guides was used, dumping automatically into the hopper.

For mixers used in streets where only one track was kept open, and where there was no traffic between the machine and the side of the street, the charging bucket was at the side of the machine, with a wheeling platform laid parallel with the track. For those used where traffic was maintained on a track between the sidewalk and the track under construction, the charging bucket was at the front end of the mixer car and a platform mounted on small wheels was placed between this car and the motor car. This reduced to a minimum the danger of wheelbarrow men being struck by passing cars and also provided a place for loaded wheelbarrows to stand (out of the way of traffic) while waiting for a charge to be mixed and dumped. There are two men in the mixer car; one to control the motor of the bucket hoist, and the other to attend to the water supply, the discharge of the concrete and the movement of the chute. Fig. 8 shows one of these concrete-mixing machines at work.

On some parts of the work, the mixers were of the trough type, with revolving paddles, as illustrated in our issue of Nov. 7, 1907. These were mounted on long steel-frame motor cars, the mixer being placed parallel with the track. Along the middle of the floor (forward of the mixer) was a steel supply trough in which traveled a drag-chain conveyor to feed material to the mixer. In making concrete with machines of this class, the stone and sand was piled in a longitudinal ridge or windrow beside the track; as the machine advanced, cement was spread upon this, and the material shoveled into the trough by a gang of men, thus avoiding the use of wheelbarrows. In any case the concrete was mixed fairly wet and discharged at the rear of the car directly in place, a swiveling chute being used to deliver it between or outside of the rails. It was shoveled under the ties, and lightly tamped, being leveled by means of a template grooved to ride upon the rails. The concrete was at once covered with a thin layer of dry cement and sand. The concrete covered the ties and the base of the rails, but at the joints the rails were left exposed for the subsequent operation of welding.

Cement mortar (1:3) was packed against the webs of the rails as a filler. A bed of sand was spread on the concrete and the granite blocks were laid on this, the blocks having been distributed along the track from motor flat cars. This paving was grouted with a hot pitch composition poured into the joints, and fine clean gravel was swept into the joints. The gravel was also spread on the paving, with the view of being worked into the joint by the traffic, but as a matter of fact this was mainly crushed to powder under the

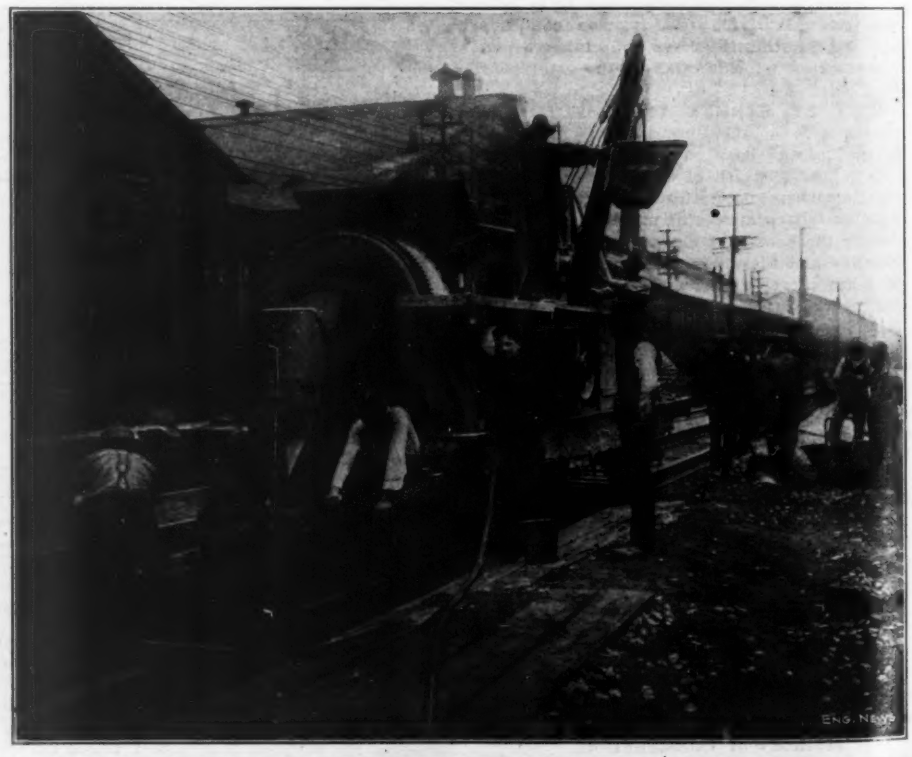
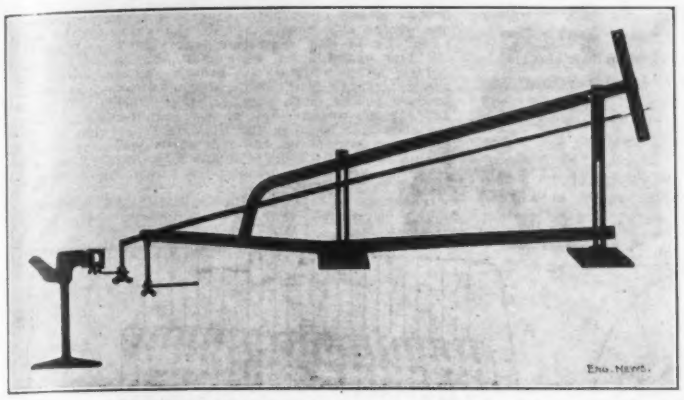
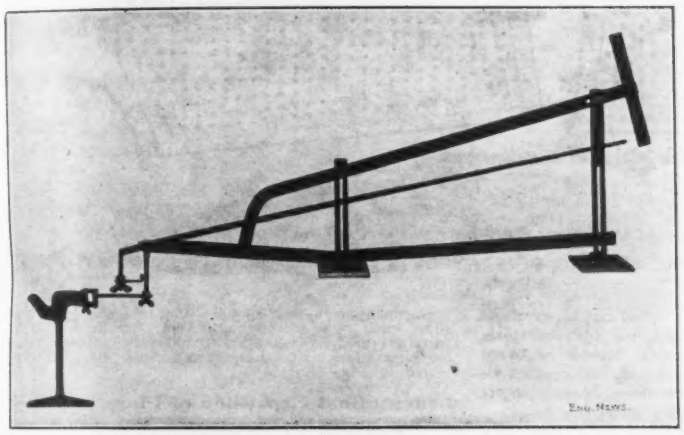


FIG. 8. CONCRETE MIXING MACHINE DEPOSITING CONCRETE IN STREET RAILWAY TRACK CONSTRUCTION.

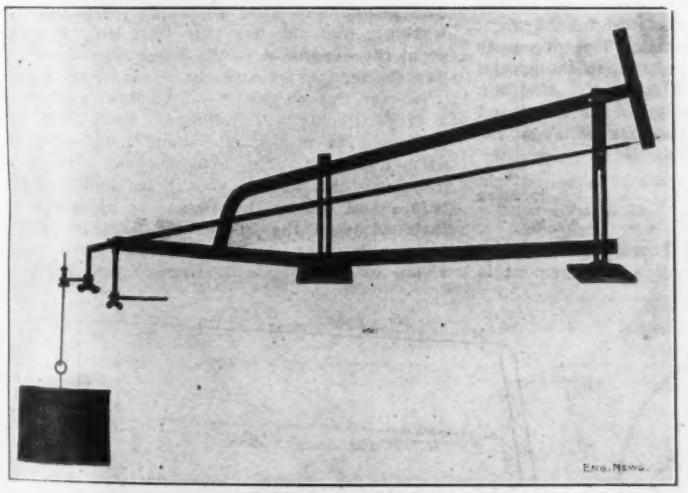
wheels and became a nuisance. Cement filler for this block paving was used also, but proved less satisfactory in some cases. On some parts of the work, creosoted wooden block paving was laid. Finally the paving at the sides of the street was taken up and relaid (usually with the old material) to a steeper crown to reach from the old gutter grade to the new grade of the tracks in the center of the street. Much of the track paving was done in advance of the welding of



A. Measuring Vertical Deflection of Rail.



B. Measuring Lateral Deflection of Rail.



C. Measuring Deflection of Tie.

FIG. 9. DEFLECTOMETER FOR MEASURING THE VERTICAL AND LATERAL DEFLECTIONS OF STREET RAILWAY TRACK UNDER TRAFFIC.

the joints, and was omitted at the joints. The track was required to be left for 7 days before the joint welding machines were run upon it, and 14 days before it was opened to traffic.

Track Deflection.

An interesting work in connection with the track reconstruction was the making of tests to determine the vertical deflection and lateral movement of the new track under traffic, the new double-truck cars weighing about 35 tons. For this purpose a special "deflectometer" instrument was devised by Mr. R. F. Kelker, Jr., Assistant Engineer. This is shown in Fig. 9, and its use is described as follows in a paper read by Mr. Geo. Weston before the Western Society of Engineers:

During the winter of 1908 the track built during the previous year was carefully inspected to ascertain its behavior under traffic and it was found in places that a slight movement in the rail could be detected under the load of passing cars. The Chief Engineer directed that an investigation be made to ascertain the cause of the movement, to what extent it affected the track construction, and what the possible results might be.

In order to make this study and determine the rigidity and action of the different types of track construction under traffic, observations were taken by means of a "deflectometer," designed especially for the purpose. This apparatus was so constructed that lateral movement of the rail could be observed as well as vertical deflection, and it was also arranged so that any vertical movement of the ties in the concrete could be readily determined and measured. The principal object of the investigation was to determine if any movement occurred of sufficient magnitude tending to disintegrate the concrete foundations or to endanger the life of the track substructure. The deflectometer consists of a simple lever mounted on a suitable frame, having at its outer end a pointer which moved over a scale. This lever is proportioned for a ratio of 10 to 1. The distance from the rail to the fulcrum being 4 ins., that from the fulcrum to the scale is 40 ins. The frame is designed so that the joints of the supporting frame are adjustable to compensate for any inequality in the pavement, so the apparatus can be brought to a true level when the readings are being taken.

In order to segregate the vertical movement from the horizontal movement of the rail, a small clamp was made to be attached to the outer side of the rail. This clamp is placed on the under and outer surfaces and highly polished so that the point of contact with the lever will move over these surfaces without friction.

To take readings for vertical deflection, the instrument was set at right angles to the track and the frame adjusted to a true level, the clamp applied to the head of the rail and the short arm brought into contact with the under surface of the clamp. (See A, Fig. 9.) With the instrument in this position it will be seen that any vertical movement that takes place in the rail under load would be transmitted to the pointer at the scale and would be magnified ten times. In this position the instrument records only vertical movement.

To measure horizontal movement of the rail the other arm is brought into contact with the outer surface of the clamp, and in this position, any horizontal movement is transmitted to the pointer on the scale in the same manner as recording vertical movement. When in this position only horizontal movement will be recorded. (See B, Fig. 9.)

To take readings for the deflection of the tie, a longer arm was attached to the apparatus which was fastened to the tie by means of a screw eye when applied to wood ties (as at C, Fig. 9), and when the observations were being made on steel ties the arm was hooked under the flange. When readings were taken of the concrete substructure a small hole was drilled into the concrete and plugged with lead and a small screw eye inserted as in the case of the wood tie.

When these tests were taken it was expected that deflection amounting to as much as from ¼-in. to ½-in. would be found in some places. The results obtained were an agreeable surprise, for the maximum vertical deflection recorded was 5/64-in. In a large percentage of the track tests, no vertical deflection whatever was noted. It was also shown by these tests that greater vertical deflection occurred at the rail joints, and decreased away from the rail joints, and that the average vertical deflection observed seemed to be about 1/32-in. No deflection whatever was observed in the concrete, and only in a very few cases was any deflection in the ties recorded. In these few instances the ties were excavated and it was found that the movement was due to improper tamping, leaving voids.

After numerous tests had been made it was determined that practically all movement took place between the base of the rail and the tie-plate, and that, in the majority of cases, this movement was observed near the joint of the rails and disappeared entirely as the center of the rail was approached. This can be explained as follows: There is an opening left in the concrete to facilitate the welding of the joint, which is done after the concrete has been placed. When the weld is made the rail fastenings on the ties adjacent to the joint are loosened, and the rail apparently buckles. After the weld is made, in retightening the fastenings the rail was not forced back to its original position on the tie-plates, and, when the loaded cars passed over the rail at these points the rail was forced down to the tie-plate, and, after the load was removed, the rail would spring back again from the tie-plate, which accounts for the vertical movement.

It should be noted that horizontal movement was recorded in practically every case of tests made. The average movement in this direction being about 1/64-in. This horizontal movement seemed to be a constant factor and varied but little in any case.

The tests proved that the eye greatly exaggerated the apparent movement of the track under load. It was discovered that, even to the eye of the trained observer, the rails that seemed to have a deflection of ¼-in. in reality did not move more than 1/64-in. These tests also demonstrated that in many instances where vertical movement of the rail seemed to be observed, it was, in fact, a horizontal movement. They further proved that it was impossible for the observer with the naked eye to differentiate between horizontal movement and vertical movement of the rail.

These observations proved that, when the foundation is properly prepared, the concrete properly mixed and placed and the ties properly tamped, and the concrete given a sufficient length of time to properly set before traffic is allowed upon the track, no movement occurs between the concrete and the soil or between the tie and the concrete, and that, when the fastenings are properly applied, no vertical movement will occur between the rail and the tie-plate. They proved also that the types of construction that are being used in the rehabilitation of the tracks, as far as can be figured at this time, have the characteristics which promise a permanent substructure.

EFFECT OF FLOODS AND INUNDATIONS ON THE PREVALENCE OF TYPHOID FEVER.—At this season of the year when we see a rise in the number of cases of typhoid fever it seems appropriate to discuss the effect of floods and inundations on its increase. Jacques Bertillon in the "Presse Médicale" for July 23, 1910, gives the results of a study of the effect of floods in various cities of Europe, notably the great flood of 1910, in Paris. It has been stated in various quarters that the effect of such a flood was to increase the dangers from typhoid fever and other epidemic diseases. The author, on the contrary, finds that the effect of the flood in Paris was not to increase the number of cases or of deaths from typhoid, but rather to decrease them. It would seem that the great washing out of the city streets had rather a cleansing effect than otherwise. A study was made of the occurrence of the fever in the arrondissements affected by the flood, and in others to which the flood did not reach, and it was rather higher in the unaffected locations. In the 54 quarters inundated there was a total of 44 deaths from typhoid in 13 weeks before the flood, and only 24 in the same number of weeks afterward. During and after the flood it is probable that the authorities were more careful in disinfection and in isolating cases that occurred than at more healthful times. In ten floods in the city of Dresden, however, typhoid fever was not increased, and the same was true in six floods in Vienna. After the analysis of all these cases it seems evident that the statement made that there is an increase of typhoid after floods is erroneous.—From New York "Medical Record."

Experimental Investigation of Inequalities of Expansion in Locomotive Boilers.

A long experience of cracked plates and broken staybolts in locomotive boilers on the New York Central Lines impelled the motive-power department to an attempt to discover by experiments the cause and cure for these troubles. The method and results of these experiments and the expedients consequently adopted were described in an address given before the New York Railroad Club at the meeting of May 20, 1910, by Mr. D. R. MacBain, Assistant Superintendent of Motive Power of the New York Central & Hudson River R. R.

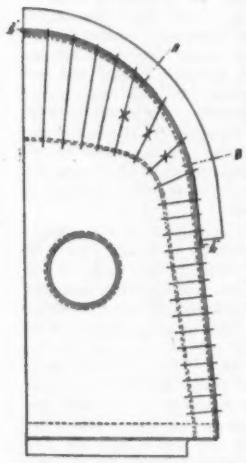


Fig. 1. Template for Investigating Expansion of Wagon Top of Locomotive Firebox.
(Showing position after steam had been raised.)

The three main points investigated were the nature of the expansion of the wagon top (the outside sheet over the firebox); the inequality of expansion between the inner and outer sheets of the firebox; and the inequality between the longitudinal expansion of the boiler shell and that of the flues themselves. Another point of interest was an experiment made to determine the effect upon the tube sheet of expanding the tube ends with a Prosser expander.

Expansion of Wagon Top.

The effect of expansion upon the shape of the wagon top was investigated by means of templates as shown in Fig. 1. Four templates, equally spaced, were fitted to the wagon top of a large Pacific-type locomotive, with a wide firebox, while the boiler was cold. Steam was then raised to a pressure of 200 lbs. per sq. in., and the templates rose to the position shown in Fig. 1. At their ends and at the point above the center of the wagon top, the templates stood away from the plate by 3/32-in. They touched only on each shoulder of the wagon top, between the points A and B, Fig. 1.

Mr. MacBain points out that this experiment seems to indicate the cause of the frequent breakage of staybolts in the three rows indicated by small crosses in Fig. 1. These three rows are in the zone AB of the template experiment. In Mr. MacBain's opinion, this shows that the wagon top and the inner wall of the firebox expand unequally, and that a tremendous stress is thereby put upon the three indicated rows of staybolts. To the same cause, he attributes the shearing of rivets in side seams of the inner firebox sheet, a common cause of annoyance in locomotives having separate crown and side sheets.

As a result of this finding, a system of slack flexible staybolts was devised which has given satisfactory results on New York Central and Michigan Central locomotives. As shown in the end view, Fig. 2, the staybolts in the rows along the shoulders of the wagon top are set 1/16-in. slack. One row at each side of these slack rows is set 1/32-in. slack, forming a more gradual transition from the loose to the taut bolts.

Inner and Outer Sheets of Firebox.

An indication of the amount of inequality of expansion between the inner and outer firebox sheets was obtained by means of measurements between marks on both sheets before and after getting up steam. Mr. MacBain's description of this experiment and his conclusions from it are as follows:

A wide-firebox boiler was selected, and a set of trams of solid steel were prepared. A set of marks, as shown in Fig. 3, was made from these trams. The boiler was then fired up and, when 200 lbs. pressure was raised and the pops had been open for a few minutes, the fire was drawn hastily, during which process the trams were tried to their respective marks on the outside sheets, and immediately afterward (within a few minutes) the trams, in the proper order, were tried to the marks on the inner sheets. The figures shown on the accompanying table are the result, indicating that the expansion of the outer sheets was greater, in every case, than that of the inner sheets.

	⌐Outside Wrapper Sheet¬		⌐Inside of Firebox¬		
Mark No.	Location.	Expansion, Ins.	Location.	Expansion, Ins.	Difference in expansion, Ins.
1	Side sheet	3/16	Side sheet	1/8	1/16
2	" "	5/32	" "	3/32	1/16
3	" "	1/4	" "	5/32	3/32
4	" "	3/16	" "	1/8	1/16
5	" "	7/32	" "	1/8	3/32
6	Wagon top	7/32	Crown "	5/32	1/16
1	Throat sheet	5/32	Tube "	7/64	3/64
2	Throat sheet	3/16		1/8	1/16
1	Back head	5/32	(No record on door sheet)		

This verifies our former opinion in that regard, and seemingly accounts for the breakage of back heads and throat sheets along the outer row of staybolts; also for vertical cracks in the side sheets, as well as the cracks up and down from the water-bar holes.

The theory is borne out by the movement of the needle shown extending through the throat sheets in Fig. 3. When the fire was first started, and before circulation was fully established, the needle moved out 3/32-in.; and later, when circulation was established and the steam pressure began to rise, the needle moved backward about 1/16-in. The first movement of the needle, we think, throws some light on the cause of side sheets puffing along the fire line, as they sometimes do.

This inequality of expansion of the inner and outer firebox sheets is provided for, in the slack staybolt installation shown in Fig. 2, by setting the bolts in the rows nearest the four upright corners of the box 1/16-in. slack. The next rows are set 1/32-in. slack. In addition to the special installation, as shown in Fig. 2, Mr. MacBain advises slack braces for the back flue sheet and a full installation of flexible staybolts in the throat sheet, set loose, as follows:

First row above mud ring	Tight
Second row above mud ring	1/32-in. Slack
All others	1/16-in. "
Black flue-sheet braces	3/32-in. "

Besides avoiding excessive breakages of staybolts and flue-sheet braces, this arrangement is expected to reduce the strain on the arch-flue anchorages. The complete special installation, including the above addition, in Mr. MacBain's opinion, will increase the life of a modern firebox by 50 to 75%.

The results obtained from a full installation of flexible staybolts, including radial stays, with the slack adjustment indicated in Fig. 2, are described by Mr. MacBain as follows:

This installation of flexible staybolts was made in January, 1907, and the engine was put into heavy passenger service. It was our intention to have made this firebox of one piece but, owing to a defect developing in one of the side sheets, a half side sheet had to be applied. Up to Feb. 1, of this year (1910), at which time the last examination was made, the engine had made 243,000 miles without one broken staybolt, without any vertical cracks in the side sheets, without any trace of a crack in the back head, or throat sheets, and without any cracks, or any sign of a crack, leading away from the arch-tube holes in the back flue sheet, nor has there ever been a tool on the side-sheet seam; in fact, the engine has never been held one moment for boiler work, other than that of expanding the flues, since it went into service in February, 1907.

Inasmuch as this engine has continually carried a double-brick arch—that is, the old Coffin-McGeath brick-arch installation—we consider the record of this side-sheet seam very exceptional indeed. We believe the results obtained in this locomotive firebox are due to the loose installation of staybolts and radial stays, as illustrated in Fig. 2.

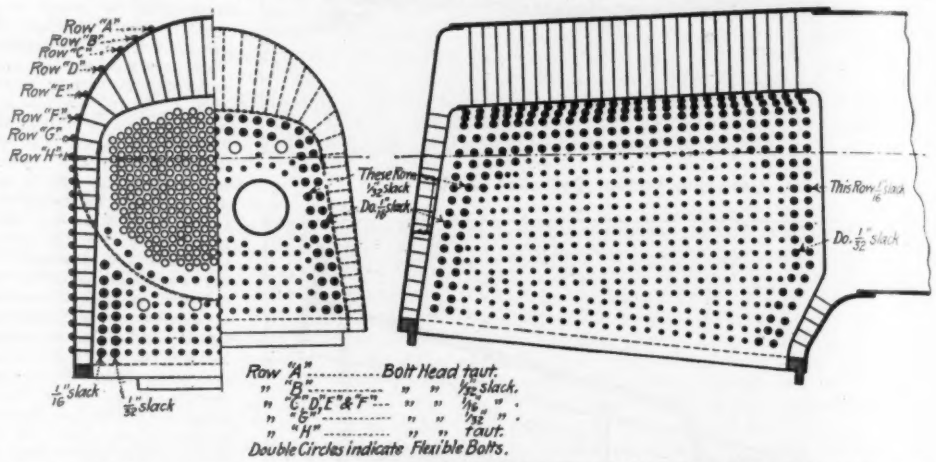


FIG. 2. PROPOSED SPECIAL SETTING OF STAYBOLTS TO ACCOMMODATE INEQUALITIES OF EXPANSION.

Longitudinal Expansion of Flues and Shell.

Very interesting experiments were made to substantiate a theory as to the reason why locomotive flue sheets become displaced or distorted. The theory was, that while the locomotive was working, and the fire hot, with the circulation good, the expansion in the boiler barrel, between flue sheets, was greater than that of the flues.

To test this theory, a set of flues was put in a large Pacific-type locomotive with each flue depressed at mid-length about 1 in. below its normal position. The deflection was obtained by pressing down upon each tube at mid-span just before and during the expanding process which fastened it to the tube sheet. This work was done with great care under the personal supervision of Mr. F. A. Linderman, Supervisor of

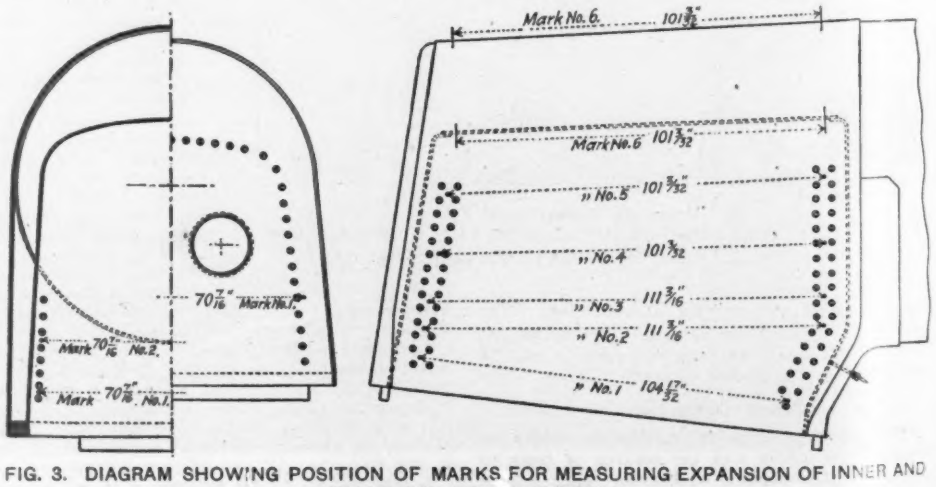


FIG. 3. DIAGRAM SHOWING POSITION OF MARKS FOR MEASURING EXPANSION OF INNER AND OUTER SHEETS OF FIREBOX.

Boilers of the New York Central & Hudson River R. R. With this arrangement any inequality of expansion between the flues and the shell will be accompanied by an increase or decrease in the amount of this deflection in the flues. When the shell expansion exceeds that of the flues, they will straighten out, and their deflection will be diminished. On the other hand, if the flues were to expand more than the sheet, their deflection would increase.

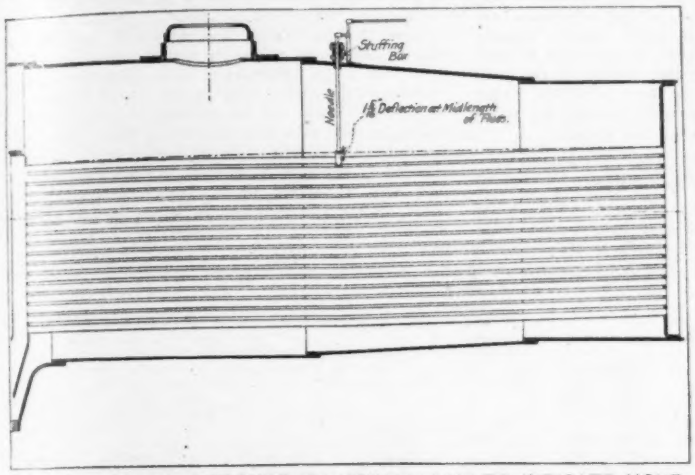


FIG. 4. NEEDLE ATTACHED TO BOILER FLUE TO INDICATE MOVEMENT UNDER WORKING CONDITIONS.

(Note special setting of flues with about 1 in. more than normal sag at mid-length.)

The device by means of which the change of deflection was observed and recorded is illustrated in Fig. 4. A vertical needle was secured to one of the top flues midway between the flue sheets, that is, at the point of maximum deflection, and was brought out through a loosely packed stuffing-box in the top of the boiler shell. Any change in the deflection of the flue was, then, revealed by a corresponding vertical movement of the needle. The needle was connected to a recording device so that graphical records could be made of the movement of the flue.

CURVES.—Three such records, Figs. 5, 6 and 7, are discussed in Mr. MacBain's address. One of these, Fig. 5, was made to show the movement of the flue while firing up the boiler; the other two were made during regular runs on the road.

Mr. MacBain's discussion of these charts is as follows:

Fig. 5 shows the movement of the tube, to which the needle was attached, from the time the fire was started until 200 lbs. pressure was raised. It will be noted that almost immediately after the fire was started the needle began to pull downward, and continued in that direction until it had pulled downward fully ⅛-in. and remained practically stationary for a few moments; then began to rise, as shown, and continued upward until about ⅛-in. above the normal position.* At this point the steam pressure began to rise, and the rise of the needle from there until the pressure reached 175 lbs. was gradual. The rise of the needle was very rapid from 175 to 200 lbs., with the result that the total rise above the normal line was $^{12}/_{16}$-in. We cannot account for the rapid rise of the needle during the time the pressure increased from 175 lbs. to 200 lbs., unless it might be that the needle did not work in the stuffing box quite as freely as it should; but we cannot see how that could have been, as the packing in the stuffing box around the needle was very loose.

Arrangements were then made to make a road test, and the record made by the recording device used is shown in Figs. 5 to 7. This road test was made, as was the shop test, by Mr. Linderman and Mr. McPartland, the latter an engineer of long experience in testing locomotives and their appliances.

Fig. 6 is a record made by the recording device on the first road trip, which was from West Albany to Rotterdam Junction.* It will be noted that, immediately upon starting out, the needle began to pull downward, as shown by the solid lines; the dotted lines being the record made after the throttle was closed and while drifting. The maximum downward pull on the needle was $^{2}/_{16}$-in., this point having been reached while the engine was being worked hard and running at good speed.

Fig. 7 is a record of the second road test, which was made from Utica to Palatine Bridge. We cannot explain the rise of $^{1}/_{16}$-in. above the normal line at the start of this trip, but it will be noted that it did not occur again. The balance of the record, you will observe, is nearly a repetition of what occurred on the first trip. The increase on the downward pull on the needle, in our opinion, was due to the engineer who was running the engine on this trip working the engine harder than did the engineer who handled it on the first test. The maximum pull downward on the needle was $^{5}/_{16}$-in. At no time in the road test did the needle go down to the original position, as when the boiler was cold. The breaks in the card indicate the periods during which the apparatus was cut out while switching was being done; and the line at the right of the card, which shows the needle raised to the normal line, followed quite a long stop at a station.

SERVICE RECORD OF THE TEST LOCOMOTIVE.—The flue installation on this locomotive differed somewhat from the standard New York Central practice in other particulars beside that of greater deflection. The standard-gage flue, on the New York Central Lines, is No. 11, B. W. G. In the test boiler, however, a set of tubes of No. 13 B. W. G. was installed, and one-half of the total number of tubes were safe-ended with No. 11 B. W. G. The arrangement of the plain and the safe-ended flues is shown in Fig. 8.

The engine on which this test was made was subsequently put into regular service on heavy passenger trains, to ascertain the behavior of the unusual flue installation. Another engine of exactly the same class, but having a standard installation of No. 11-gage flues, was put on in the same line of service at the same time. A record of the performance and cost of maintenance of the two engines shows appreciable advantages in favor of the one with the lighter-gage, deflected tubes. These advantages are set forth by Mr. MacBain as follows:

The engine with the special flues and special setting, in making 69,856 miles, never failed, while the engine with standard flues and standard setting, in making 71,774 miles, had a few detentions charged to it on account of "flues leaking." The cost of maintenance of both engines is as follows:

Special flues and special setting:	
Cost per mile for flue work at engine houses..	$0.0143
Standard flues and standard setting:	
Cost per mile for flue work at engine houses..	.0195
Percentage in favor of special setting.....	26.7%

At the time these figures were made up there was no perceptible difference in the condition of the flues in the firebox of either engine. The No. 13 heads seem to have stood the working as well as the No. 11 heads. This, we believe, was due to the fact that the No. 13 heads did not leak as often as did the No. 11 heads and therefore did not require to be worked as much.

Effect of Expanding the Tube Ends.

The amount of expansion or stretching of the flue sheet that results from fastening in place a set of flues with a Prosser expanding tool was investigated by Mr. Linderman as illustrated in

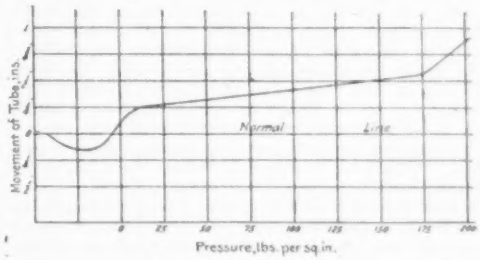


Fig. 5. Curve Showing Movement of Tube While Boiler Was Being Fired Up Without Blower.

Fig. 8. The dotted circle and lines were made on a new flue sheet before the tubes had been set. The tubes were then "expanded," with the result that the circle and other marks assumed the positions shown by the solid lines. The lines moved from 1/32 to 3/32-in., and the maximum movement was toward the top and the upper corners of the sheet. The Prosser tool, in Mr. MacBain's opinion, is less injurious in this respect than the ordinary roller expander.

From this experiment the importance of curtailing the use of the expanding tool is evident. The expanding process is resorted to ordinarily about once a month, or oftener, during the time a locomotive remains out of the shop.

Summary.

The effects of expansion, Mr. MacBain concludes from the foregoing experiments, are to increase the distance between the inner and outer sheets of the firebox and to cause an increase of length in the boiler barrel, between tube sheets, greater than the corresponding increase in the length of the tubes. This is due, he believes, to the inner firebox sheet and the flues being at a lower temperature, when the circulation is good, than that of the outer firebox sheet and the boiler shell, respectively. On the ground that the stresses due to heat expansion of boiler iron are practically irresistible, Mr. MacBain advances the theory that the construction of a boiler should not be designed to oppose this expansion but should be made sufficiently flexible to permit it without injurious effects.

Whether or not it be conceded that Mr. MacBain is correct in his deductions—in ascribing the results described to differences of temperature rather than to steam pressure—the experiments themselves are of more than ordinary interest.

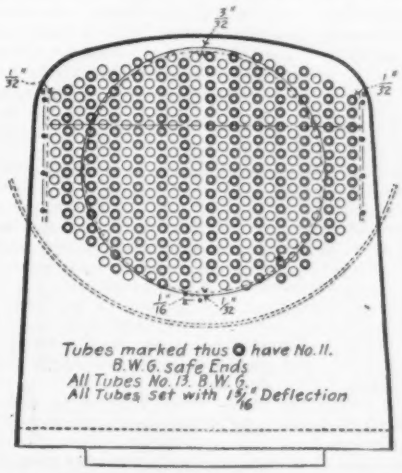


Fig. 8. Special Setting of Flues for Test Boiler; Showing Results of Expanding the Tube Ends.

(A circle scribed on tube-sheet was moved outward from 1/32 to 3/32-in. by the expanding process.)

*"Normal position" here refers to the position of the tube when cold; that is, deflected $1^{3}/_{16}$-ins. below a straight line joining its ends. This deflection is described by Mr. MacBain as about 1 in. more than the natural sag caused by the flue's own weight.—Ed.

*The "normal position" on this chart is not the same as that in Fig. 5. Here it refers to the position of the tube at the start of the run; that is, with steam up, but with the engine not working. Thus the "normal" position of Figs. 6 and 7 corresponds with the highest point of the curve in Fig. 5.—Ed.

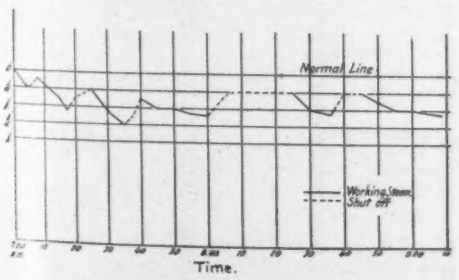


Fig. 6. West Albany to Rotterdam Junction.

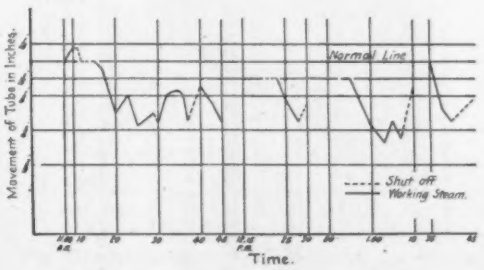


Fig. 7. Utica to Palatine Bridge.

FIGS. 6 AND 7. MOVEMENT OF BOILER TUBE IN ROAD SERVICE.

Depreciation in Water-Works Operation and Accounting.*

By LEONARD METCALF,† M. Am. Soc. C. E.

That the author may not hereafter be charged with plagiarism he calls attention to the fact that a portion of this paper was written by him early in the year 1910, for insertion in a report (made by Mr. John W. Alvord, of Chicago, and the writer) upon the reproduction cost of the water-works supplying one of the larger cities of the United States. It was subsequently used, in part, by Mr. Alvord (as stated by him at the New Orleans Convention of the American Water Works Association, held in April, 1910), as a basis for the progress report to that association of the "Committee on Depreciation," of which Mr. Alvord was the chairman and the writer was a member. The water company officials have courteously consented to the use of the material submitted to them, and it was thought that the fact that some of the opinions expressed had been reported to an operating company, as suggestions bearing upon its future government, might give it an added interest.

The Decision of the Supreme Court of the United States upon the Knoxville Water Works Case, delivered by Mr. Justice Moody, and handed down in January, 1909, gives emphasis to the need of practical recognition of depreciation by managers of public-service corporations, and will effectually estop hereafter any corporation from making claim for the effect of depreciation of its property that has failed to earn, through the agency of its rate, a sufficient fund to meet this depreciation.

Exception might be made in the plants which have not yet passed through the formative period, or which, by reason of heavy reconstruction expenses, have not been able to lay aside a suitable depreciation fund without increasing the rates. Such plants may have preferred to temporarily suspend the laying aside of a depreciation allowance, in the hope of making good the deficit a few years later, rather than to bear the public odium of temporary increase in rates. It seems reasonable to assume that a public-service commission would take the same view.

Methods of Computing Depreciation Fund.

Granting that the water-works should lay aside an annual depreciation account which, with or without its accretions, depending upon the method of raising and maintaining this fund, will be sufficient to maintain in the hands of the corporation money which will enable it to replace each component part of the plant at the end of its useful life, thus maintaining the investment unimpaired, "What method is the most satisfactory for accomplishing this end, that is, for determining the annual sum which shall be contributed to the depreciation fund?"

Two general methods are in common use—the so-called "sinking fund" method and the "straight line" method.

The *sinking fund method*, as its name implies, consists in laying aside each year, during the period of life of the structure under question, a sum which with its annual accretions, compounded annually at an assumed rate of interest, will leave in hand, at the end of the useful life of the structure, a sum equal to its original cost less its scrap value.

Owing to the fact that the scrap value of the structure frequently is little more than sufficient to cover the cost of its removal and that, in the case of a long lived structure, the present worth of the scrap value would be exceedingly small, engineers have generally omitted the correction for the scrap value of the structure and have assumed, unless the life of the structure was comparatively short, that the scrap value is negligible. In the case of very short lived structures it is better that the cost of the structure be charged off to operating expense, rather than to capital account with large annual allowances for depreciation.

The *straight-line method* consists in laying aside an annual sum proportioned to the length of useful life of the structure.

The essential differences between these two methods of meeting the needs of the depreciation account are:

(1) The fact that the *sinking-fund method* requires not only an annual contribution to the principal sum of the depreciation account, but that care be observed in the method of accounting for this fund, to the end that it may receive annual accretions of interest, which accretions with the principal sum and contributions will receive annual interest, so that the fund may, in fact, be a true sinking fund and enjoy the compounding affect of the interest allowances.

In the case of the *straight-line method*, no accretions or interest allowances are credited to the fund—the principal sum of the annual deposits being sufficient alone to make up the necessary depreciation fund at the end of the useful life of the structure. Such earnings, therefore, as may be enjoyed upon the straight line depreciation account should be credited to the general operation of the works and not to the depreciation account itself—whereas the reverse is the case in the sinking fund method of application.

(2) Of perhaps greater importance to the operator of water-works—particularly of new works—the sinking fund method requires much smaller annual contributions to the depreciation accounts, and the accretions thereon amount to a much smaller sum, during the early years of the life of the plant, whereas in the later years, the accretions become a very important element, rapidly swelling the amount of the fund. It will thus be seen that the works are relieved by this method, in the early years of the formative period, from a burden which might prove heavy for the corporation and the water takers to bear under the straight-line method.

Reasonable Assumptions as to Period of Useful Life of Structure.

These methods are but aids to judgment. They must be applied with care and discretion, and with a clear conception of the extent and effect of the local influences or considerations. No subject in the engineering field requires larger experience or riper judgment.

While general limits for depreciation in water-works property, found under what might be considered normal conditions, may be indicated and are submitted herein, the fact that local conditions and limitations are likely to have substantial influence upon current depreciation in any specific plant must never be lost sight of.

Final analysis of the necessary amount of the contributions to depreciation fund ultimately resolves itself into a question of expediency and standards of the day. It is well to be conservative in forecasting the annual needs for depreciation, alike in the interest of the public and of the corporation whose funds are invested in the plant; for it is easy to charge off, or make future abatement, for an excessive amount earned by the rates and credited to depreciation account, while it may be difficult later to recover, by increased depreciation allowances, earlier deficits caused by failure to make adequate allowance therefor. In the long run, failure to make

TABLE I.—APPROXIMATE LIFE AND CORRESPONDING ANNUAL PERCENTAGE CONTRIBUTIONS TO SINKING FUND.

Water-works structures.	General limits of useful life years.	Corresponding annual contribution to depreciation account at end of year in per cent. of cost of structure,* based upon Sinking fund method, using interest rate compounded annually at 5%.	4%.	3%.	2½% to 4%, depending upon length of life.	Straight-line method.
Reservoirs	50 to 100	½ to 0†	⅝ to ⅛	⅝ to ⅛	0.89 to 0.23	2 to 1
Steel stand-pipes	25 to 40	2⅛ to ¾	2⅜ to 1	2⅝ to 1⅝	2.57 to 1.33	4 to 2½
Masonry buildings	30 to 50	1⅛ to ½	1⅜ to ⅝	1⅝ to ⅞	2.02 to 0.89	3⅓ to 2
Wooden buildings	20 to 40	3 to ¾	3⅜ to 1	3⅝ to 1⅝	3.54 to 1.33	5 to 2½
Filter plants, permanent constr't'n	25 to 50	2 to ¼	2⅜ to ⅝	2⅝ to ⅞	2.57 to 0.89	4 to 2
Pumping machinery, high-duty in large units	30 to 50	1⅛ to ½	1⅜ to ⅝	1⅝ to ⅞	2.02 to 0.89	3⅓ to 2
Ordinary pumping machinery	20 to 30	3 to 1⅛	3⅜ to 1⅜	3⅝ to 1⅝	3.54 to 2.02	5 to 3⅓
Steam engines	15 to 25	4⅝ to 2⅛	5 to 2⅝	5⅜ to 2⅝	5.09 to 2.57	6⅔ to 4
Boilers	12 to 20	6¼ to 3	6⅝ to 3⅝	7 to 3⅝	6.66 to 3.54	8⅓ to 5
Electric generators and motors	20 to 30	3 to 1⅛	3⅜ to 1⅜	3⅝ to 1⅝	3.54 to 2.02	5 to 3⅓
Masonry conduits	50 to 100	⅛ to 0†	⅝ to ⅛	⅞ to ⅛	0.89 to 0.23	2 to 1
Cast-iron pipe, large dia.:						
In non-tuberculating waters	60 to 100	¼ to 0†	⅝ to ⅛	⅝ to ⅛	0.67 to 0.23	1⅔ to 1
In tuberculating waters	50 to 75	⅛ to ⅛	⅝ to ¼	⅞ to ⅜	0.89 to 0.41	2 to 1⅓
Cast-iron pipe, small dia.	30 to 50	1½ to ⅛	1⅝ to ⅝	2⅛ to ⅞	2.02 to 0.89	3⅓ to 2
Steel pipe	25 to 40	2⅛ to ¾	2⅝ to 1	2⅞ to 1⅝	2.57 to 1.33	4 to 2½
Wood stave pipe	20 to 30	3 to 1½	3⅜ to 1⅝	3⅝ to 2⅛	3.54 to 2.02	5 to 3⅓
Wrought-iron service pipes	15 to 30	4⅝ to 1½	5 to 1⅝	5⅜ to 2⅛	5.09 to 2.02	6⅔ to 3⅓
Hydrants	35 to 50	1⅛ to ½	1⅜ to ⅝	1⅝ to ⅞	1.58 to 0.89	3 to 2
Valves	40 to 50	⅜ to ⅛	1 to ⅝	1⅜ to ⅞	1.33 to 3.89	2½ to 2
Meters	15 to 25	4⅝ to 2⅛	5 to 2⅝	5⅜ to 2¾	5.09 to 2.57	6⅔ to 4

*By cost of structure is meant first cost of the physical structure including allowance for "interest during construction" and "engineering and contingencies" items, but excluding "going value" and "franchise value."
†Less than ⅛%.

TABLE II.—SINKING FUND DATA.*

Annual contributions to sinking fund in percentage of first cost, with different assumed interest rates upon sinking fund accumulations.

Life of structure, years.	3%.	4%.	5%.	6%.	Variable† (4% to 2½%).	Straight-line method.
5	18.8355%	18.4627%	18.0975%	17.7396%	18.46%	20.00%
10	8.7231	8.3291	7.9505	7.5868	8.33	10.00
15	5.3767	4.9941	4.6342	4.2963	5.09	6.67
20	3.7216	3.3582	3.0243	2.7185	3.54	5.00
25	2.7428	2.4012	2.0952	1.8227	2.57	4.00
30	2.1019	1.7830	1.5051	1.2649	2.02	3.33
35	1.6539	1.3577	1.1072	0.8974	1.58	2.86
40	1.3262	1.0523	0.8278	0.6462	1.33	2.50
45	1.0785	0.8262	0.6262	0.4700	1.08	2.23
50	0.8865	0.6450	0.4777	0.3444	0.89	2.00
55	0.7349	0.5231	0.3667	0.2537	0.73	1.82
60	0.6133	0.4202	0.2828	0.1876	0.67	1.67
65	0.5146	0.3390	0.2189	0.1391	0.57	1.54
70	0.4337	0.2745	0.1699	0.1033	0.48	1.43
75	0.3668	0.2229	0.1322	0.0769	0.41	1.33
80	0.3112	0.1814	0.1030	0.0573	0.40	1.25
85	0.2647	0.1479	0.0803	0.0427	0.35	1.18
90	0.2256	0.1208	0.0627	0.0318	0.30	1.11
95	0.1926	0.0987	0.0490	0.0238	0.26	1.05
100	0.1647	0.0808	0.0383	0.0177	0.23	1.00

*NOTE.—Deposits at end of year, compounded annually.
†4% Sinking fund rate for 0 to 14 years life inclusive.
3¾% " " " " 15 to 19 " " "
3½% " " " " 20 to 25 " " "
3¼% " " " " 26 to 35 " " "
3 % " " " " 36 to 55 " " "
2¾% " " " " 56 to 75 " " "
2½% " " " " 76 up.

TABLE III.—SINKING FUND DATA CONTINUED.

Approximate age in years at maturity or end of life of structure, with different assumed interest rates upon sinking-fund accumulations.

Sinking fund, in per cent.	3%.	4%.	5%.	6%.	Variable (2½% to 4%)	Straight-line method.
¼	87 years	72 years	62 years	55 years	97 years	400 years
⅜	74 "	63 "	55 "	49 "	83 "	267 "
½	66 "	56 "	49 "	44 "	69 "	200 "
⅝	59 "	51 "	45 "	41 "	62 "	160 "
¾	54 "	47 "	42 "	38 "	54 "	133 "
⅞	50 "	44 "	39 "	35 "	50 "	114 "
1	47 "	41 "	37 "	33 "	47 "	100 "
1¼	41 "	37 "	33 "	30 "	41 "	80 "
1½	37 "	33 "	30 "	28 "	37 "	67 "
1¾	34 "	30 "	28 "	26 "	34 "	57 "
2	31 "	28 "	26 "	24 "	30 "	50 "
2½	27 "	24 "	23 "	21 "	25 "	40 "
3	23 "	22 "	20 "	19 "	22 "	33 "
3½	21 "	19 "	18 "	17 "	20 "	28 "
4	19 "	17 "	17 "	16 "	18 "	25 "
5	16 "	15 "	14 "	14 "	15 "	20 "
6	14 "	13 "	12 "	12 "	13 "	17 "
7	12 "	12 "	11 "	11 "	12 "	14 "
8	11 "	10 "	10 "	10 "	11 "	12 "
9	10 "	9 "	9 "	9 "	10 "	11 "
10	9 "	9 "	8 "	8 "	9 "	10 "
15	6 "	6 "	6 "	6 "	6 "	7 "
20	5 "	5 "	5 "	5 "	5 "	5 "

*Condensed from a paper read before the New England Water Works Association at Rochester, N. Y., Sept. 22, 1910. The paper will be published in full in the Journal of the Association.

†Of Metcalf & Eddy, 14 Beacon St., Boston, Mass.

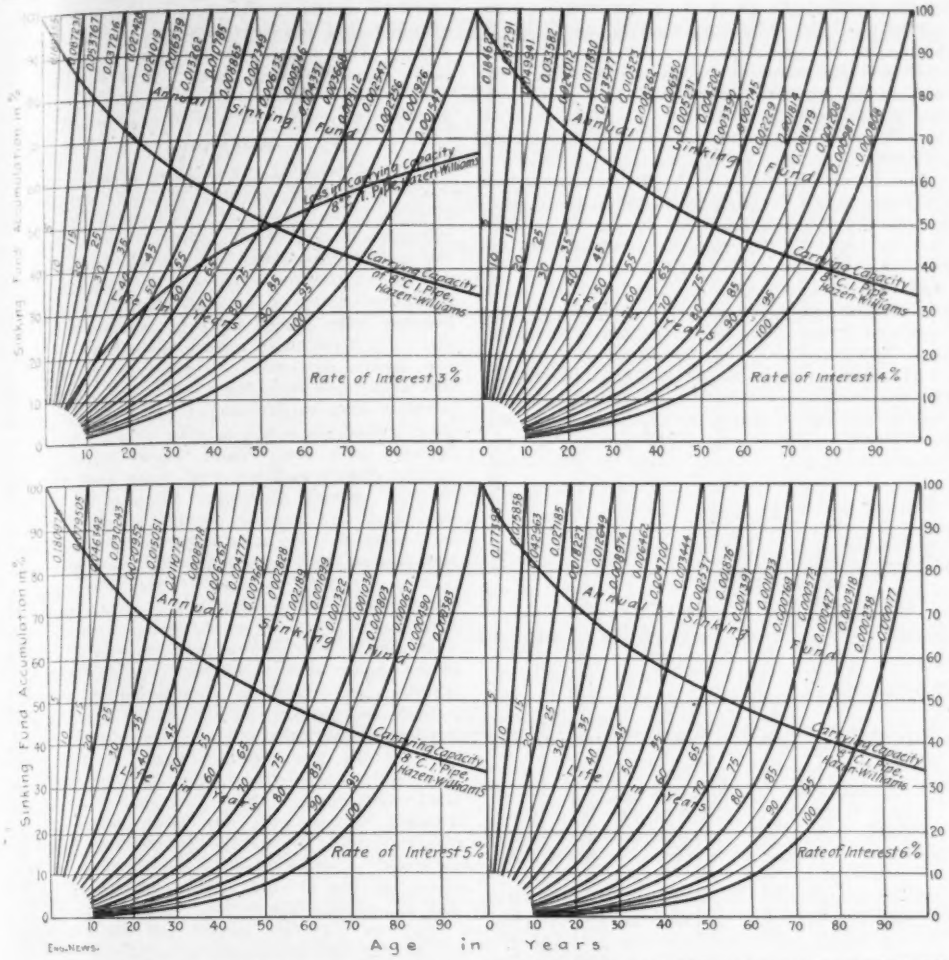

Rate of Interest 3%
Rate of Interest 4%
Rate of Interest 5%
Rate of Interest 6%
Annual Sinking Fund
Carrying Capacity of C.I. Pipe, Hazen-Williams
Loss in Carrying Capacity of C.I. Pipe, Hazen-Williams
Sinking Fund Accumulation in %
Age in Years

FIG. 1. DEPRECIATION DIAGRAMS BASED ON THE SINKING FUND METHOD, WITH RATES OF INTEREST OF 3, 4, 5 AND 6%.

(Interest compounded annually, with contributions at end of year.)

ample provision for depreciation, either through failure to earn it by the rates or to retain it in the treasury for legitimate corporate use (not for disbursement in dividends), must inevitably, upon the one hand make capital apprehensive of the soundness of the management, if not of the project itself, and thus lead to demands for higher returns commensurate with the added risk, or to flat refusal to go into the project, and upon the other, force the public to meet this demand by the payment of higher rates than would otherwise be necessary for the service rendered.

Subject to the words of caution referred to above, the accompanying approximate figures (Table I.) bearing upon the life of different structures entering into a water-works plant, are given, as representing the general range ascribed to them by competent engineers testifying in water-works valuation suits. Knowing the period of useful life of a structure the annual depreciation may be found by whatever method best fits the case. It will be well, however, to bear in mind the method to be used in figuring the depreciation, when estimating the probable life of the structure, if safe or conservative results are desired—particularly if the sinking fund method of computation is to be adopted and a high rate of interest is to be used in figuring the accretions upon the fund.

The accompanying diagrams, Fig. 1, based upon the sinking fund method and rates of interest of 3%, 4%, 5% and 6%, and Fig. 2, based upon the sinking fund method and rates of interest varying from 2½% to 4% (dependent upon the assumed length of life) will be found of service for rapid approximate computation or estimating purposes. Tables II. and III. also give similar data with greater precision. More complete information can be had from the "Robinsonian Bond and Investment Tables," published by J. Watts Robinson.

Data concerning formulas for the computation of sinking funds, etc., are to be found in a paper presented by the writer before the American Society of Civil Engineers upon "Water Works Valuation and Fair Rates," published in the "Transactions" of the Am. Soc. C. E., Vol. LXIV., p. 1, 1909, pp. 20 to 24.

The average length of life of water-works plants depends upon many factors. Broadly speaking from 40 to 60 years probably represents the usual range of life of the structures, except in the case of very rapidly growing towns or cities.

The total allowance to be made for depreciation, including contingent depreciation, will probably vary between limits of 1% and 2% per annum, though in many cases it may lie even beyond these limits. Data are scarcely sufficient at the present time to fix the proper allowance for contingent depreciation with a reasonable degree of accuracy. It seems reasonable to anticipate, however, that an allowance of not less than ¼ of 1% per annum, upon the sinking fund basis, should be provided, and in many cases, perhaps in the majority of cases, this allowance will prove inadequate. In this connection it may be of interest to cite the experience of the Knoxville Water Co., the plant of which, in a period of 17 years, showed an average annual rate of depreciation, exclusive of proper allowances for repairs and renewals, of 2.12%.

Owing to the variation in the amount of the gross income of water-works, as compared with their cost or value, the depreciation thereon, expressed in percentage of the gross income, is correspondingly variable. Broadly speaking, however, it may be said that the depreciation is likely to amount to 10%, more or less, of the gross annual income of the works.

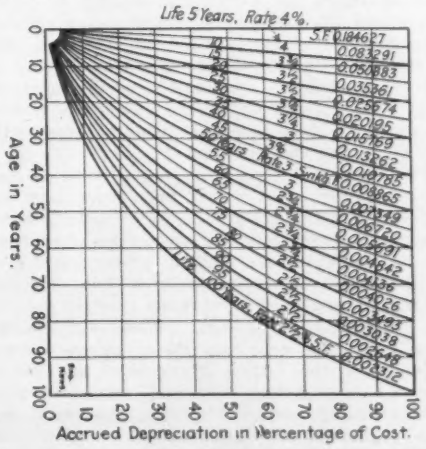


Fig. 2. Depreciation Diagram Based on Sinking Fund Method, with Interest Ranging from 2½ to 4%, According to Assumed Life of Structure.

(Interest compounded annually, with contributions at end of year.)

Thus, if we assume a plant having a value of $5,000,000, a gross annual income of 10% thereof, or $500,000 per year, and a depreciation of 1% thereof, or $50,000 per year, the depreciation will amount to 10% of the gross annual income. Assuming value $500,000, gross annual income 12% = $60,000, depreciation 1¼% = $6,250, the depreciation would amount to 10.4% of the gross annual income. Assuming value $50,000, gross annual income 16% = $8,000, depreciation 1½% = $750, the depreciation would amount to 9.4% of the gross annual income.

How many of you gentlemen, as water-works superintendents, are charging off 10% of your gross annual income to depreciation account, unless you are doing it through the agency of a sinking fund to retire the outstanding bonds upon your works?

Tests on Concrete in Sea-Water.

Behavior of cement concrete in sea-water is being investigated in the Royal German Testing Laboratory in Berlin for the Prussian Minister of Public Works, and from an article by Mr. H. Burchartz, in "The Engineer" of London, we have prepared a short description of the work so far done. Some years ago Dr. W. Michaelis, a German cement expert, stated that Portland cement should not be used in sea-water construction on account of the chemical deterioration which it would be bound to suffer there. He claimed that the free lime in Portland cement, or the lime which is set free during the hardening process, would combine with the sulphuric acid of the sea-water and cause the concrete to fail through expansion. He proposed several methods by which this action could be overcome, in all of which the lime was to be rendered harmless by the addition to the mortar of materials rich in silica. One of his other claims was that the alumina in the cement would combine with the magnesium and sulphuric acid in the sea-water to form a magnesium-aluminum sulphate, which would expand in the forming and cause failure. To overcome this defect, he proposed the use of the so-called erzcement, or iron-cement, in which the aluminates were largely replaced by iron compounds.

The tests which are being carried out in Germany were instituted to determine the truth or falsity of claim that the addition to the mortar of materials rich in silica, such, for example, as trass, would make the cement safe in sea-water. Cements rich and poor in lime were tried, and, besides mortars made with trass, others were used in which there was an addition of very finely ground sand or quartz, in order to determine whether trass acts only mechanically, by increasing the density of the mortar, or chemically as well. The tests were made both on small briquettes and on large blocks exposed to the action of the sea. It was intended to continue observation on these larger blocks over a period of 30 years, but at present the results for the five-year period alone are available. The deductions cannot be given here in detail, but the general conclusions are as follows: (1) a cement rich in lime is more suitable for constructions destined to withstand the action of the sea than one in which the lime is low. This, it will be noted, is opposed to present theory; (2) the addition of trass to cement for marine construction is of limited value only; (3) it is suitable to use for such construction, rich, dense mixtures and to have the blocks hardened in the air or under sand as long as possible before placing them in the sea. It should be stated that the cement called "rich in lime" has a percentage of lime of 65.8, while that "poor in lime" has a percentage of 61.6. The latter in the briquette tests showed lower strength and a much shorter setting period.

Observation is being made at fixed intervals upon the large concrete blocks which were placed in sea-water, and the Laboratory expects to report upon them regularly in the future.

THE USE OF HYPOCHLORITE OF LIME AT THE Boonton Reservoir of the Jersey City water-supply has been upheld by the Supreme Court of New Jersey as satisfying certain requirements as to purity in the contract between the Jersey City Water Supply Co. and Jersey City, N. J. This decision was virtually a confirmation of the Master's report, the substance of which was given in our issue of June 9, 1910.

A Reinforced-Concrete Cold Storage Warehouse at Jersey City, N. J.

By ARTHUR G. HOADLEY.*

The Union Terminal Cold Storage Co., of Jersey City, N. J., has just completed a reinforced-concrete addition to its plant, which is considered to be a model warehouse. The new addition is 72 × 100 ft. in plan and has five stories, attic and basement. It adjoins the old brick and timber construction buildings of the company.

On this site in 1906 there was built a reinforced-concrete reservoir for supplying the sprinkler system in the old building. This reservoir was built with a superstructure in view, consequently three complete rows of footings for the main building were put in place at this time; one row projecting up through the middle of the reservoir and short sections of first story columns formed and used as supports for the temporary covering. The walls of this reservoir were 8 ins. thick, reinforced with ⅝-in. square twisted bars placed 10 ins. c. to c. vertically and ½-in. bars 12 ins. c. to c. horizontally. The walls were poured in three distinct fills and the floor placed after the walls were completed, using the standard 2 × 4-in. recess at the construction joints. The inside walls of the reservoir were plastered with a thin coat of cement mortar and the floor given a granolithic finish. No waterproofing compound was used on any part of the construction, and up to the present time no leaks have shown themselves. The outside of the walls of the reservoir are as dry as though it contained no water. The top of these walls were tied into the interior columns by ⅞-in. square twisted bars, heavily painted with asphalt to prevent corrosion.

The general construction of the new building consisted of reinforced-concrete foundations, columns, floors and roof, brick exterior, hollow tile air ducts and partitions and cork insulation.

Fig. 1 illustrates the general layout of the footings and shows also the location of reservoir. Fig. 2 shows the coil chambers and fan rooms. The foundations for the new building were designed to go 2 ft. 6 ins. below those under the old building. Section c c (Fig. 2) shows the relation of the two footings. The four pier footings adjacent to the old building were put in at separate times, and buttressed columns designed to distribute the load over a greater area, thus relieving the soil immediately adjacent to the old building.

The general construction of the basement floor between the reservoir and old building consisted of footings 2 ft. 6 ins. deep with an 8-in. mat of concrete between the footings, the top of the mat being level with the top of the footings. The interior pier footings were 11 ft. 10 ins. square reinforced with ⅞-in. square twisted bars placed each way in the bottom of the footing. The amount of reinforcement and method of placing the same in the footings adjacent to the old building are shown in Fig. 1. Immediately on top of this 8-in. mat and over the tops of the footings was placed a 5-ply tar and felt waterproofing, running up on the side walls, party wall and reservoir wall to a height of 5 ft., and protected by a wall constructed of hollow tile blocks 2½ × 3 × 8 ins. On top of this waterproofing was placed a 4-in. concrete slab with a granolithic finish outside of "Area A," as indicated on Fig. 1; while inside of this area the 4-in. slab included hollow-tile blocks which were to form the first layer of insulation under the coil chambers and fan rooms.

Two entirely different systems of concrete construction were used in the first floor; first, the regular beam and girder construction which covered the reservoir and passageways in front of the coil chambers; second, a construction of 12-in. hollow tile block with a 4-in. concrete beam between each row, which covered the coil chambers and fan rooms. These 4-in. beams were reinforced with two 1⅛-in. square twisted bars, one in the bottom of the beam and one in the slab immediately over each beam. A 3-in. slab of concrete covered the 12-in. tile blocks and was reinforced by ¼-in. square twisted bars running 12 ins. c. to c. spanning the beams and 2 ft. c. to c. running with the beams. Girders 9 ins. wide and extending 6 ins. below the hollow-tile construction ran from the interior columns to the party wall and the buttressed wall columns, and supported the 4-in. beams. These girders were reinforced by three 1-in. and two ⅞-in. square twisted bars. This special floor and ceiling construction was used for the advantage it gave in the way of head room.

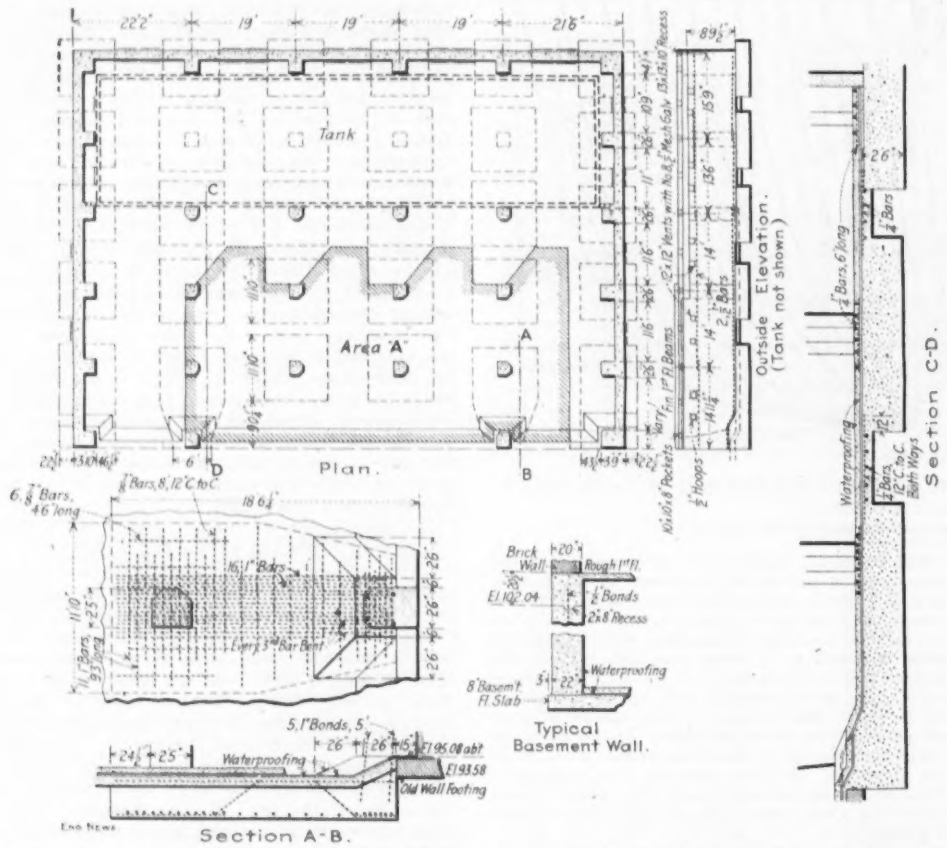


FIG. 1. FOUNDATION DETAILS OF UNION TERMINAL COMPANY'S REINFORCED-CONCRETE COLD STORAGE WAREHOUSE, JERSEY CITY, N. J.

*Superintendent, Turner Construction Co., 11 Broadway, New York City.

Insulation.

The insulation of the building presents several very interesting features in cold storage insulation. That section of floor in the basement indicated in Fig. 1 as "Area A" was used for the coil chambers and fan rooms, and was insulated in the following manner (Fig. 1). Immediately on top of the 5-ply tar and felt waterproofing were placed rows of hollow-tile blocks 2½ × 3 × 8 ins. with a 6-in. space between each row, and a 4-in. slab of concrete was cast over this area to include the blocks. On top of this concrete slab was placed a layer of the same sized hollow-tile blocks in rows with a 4-in. space between each row. These blocks were laid in cement mortar and the 4-in. space kept entirely clear of mortar drippings. Directly on top of this layer and running at right angles to it, a solid layer of these same sized blocks was placed, maintaining the 4-in. space in the under section as carefully as before. This was done in the last case by placing a 2½ × 4-in. strip of wood about 3 ft. long in the space, with rounded ends and a wire handle, and drawing it along as the upper layer progressed. When these two layers were completed they provided a well-defined ventilating and air space running the full length of "Area A." On top of the second layer of tile was placed a layer of 2-in. slab cork laid in cement mortar, the joints being filled with pitch. Over this ran a layer of Genasco roofing with the joints cemented together as carefully as though for waterproofing purposes. Another layer of 2-in. slab cork was placed on top of this, not in mortar, however, thus completing this section of insulation.

The floor over this section and the side walls of the different chambers to a height of 1 ft. 6 ins. were poured monolithically in order to ensure a water-tight compartment for use when the frost was melted off the coils in the coil chambers. A 1-in. sump 12 × 12 ins. was placed in the floor of each coil room at the low end and a small steam siphon pump connected to take care of such water.

The insulation of the first floor was applied in three different ways. Under the hollow tile construction, 2-in. slab cork was laid in cement mortar, anchored at intervals to the tile work. The balance of the first floor on the under side was insulated by placing 3-in. slab cork in the beams and girders and over the panels before placing the reinforcement. Large wire nails were driven at random into the cork to help anchor it to the concrete. Upon removing the forms the exposed surface of cork was plastered with a coat of cement mortar.

In constructing the first floor the top of the 4½-in. supporting slab in the regular construction was placed 7 ins. lower than the finished floor over the hollow-tile construction. This difference was taken up by two 2-in. layers of slab cork and a 3-in. granolithic finished floor.

The exterior wall insulation consisted of two layers of 2-in. slab cork which joined the floor insulation and was run up together with the brick work turning in again—covering the attic floor in the same manner as noted for the first floor. Before the supporting columns for the roof were placed and also before the 4 ins. of insulation was placed on the attic floor, four thicknesses of extra heavy canvas soaked in linseed oil were placed under each column with the four vertical column bars extending through the canvas. This was done to prevent the cold from escaping from the fifth floor through the columns to the attic.

The system of cooling which necessitated the layout of coil chambers and fan rooms as shown in the illustration (Fig. 2), consists of a series of tiers of 2-in. iron pipe standing vertically in each chamber and occupying practically the entire space, through which is pumped the brine from a central pumping station located in the

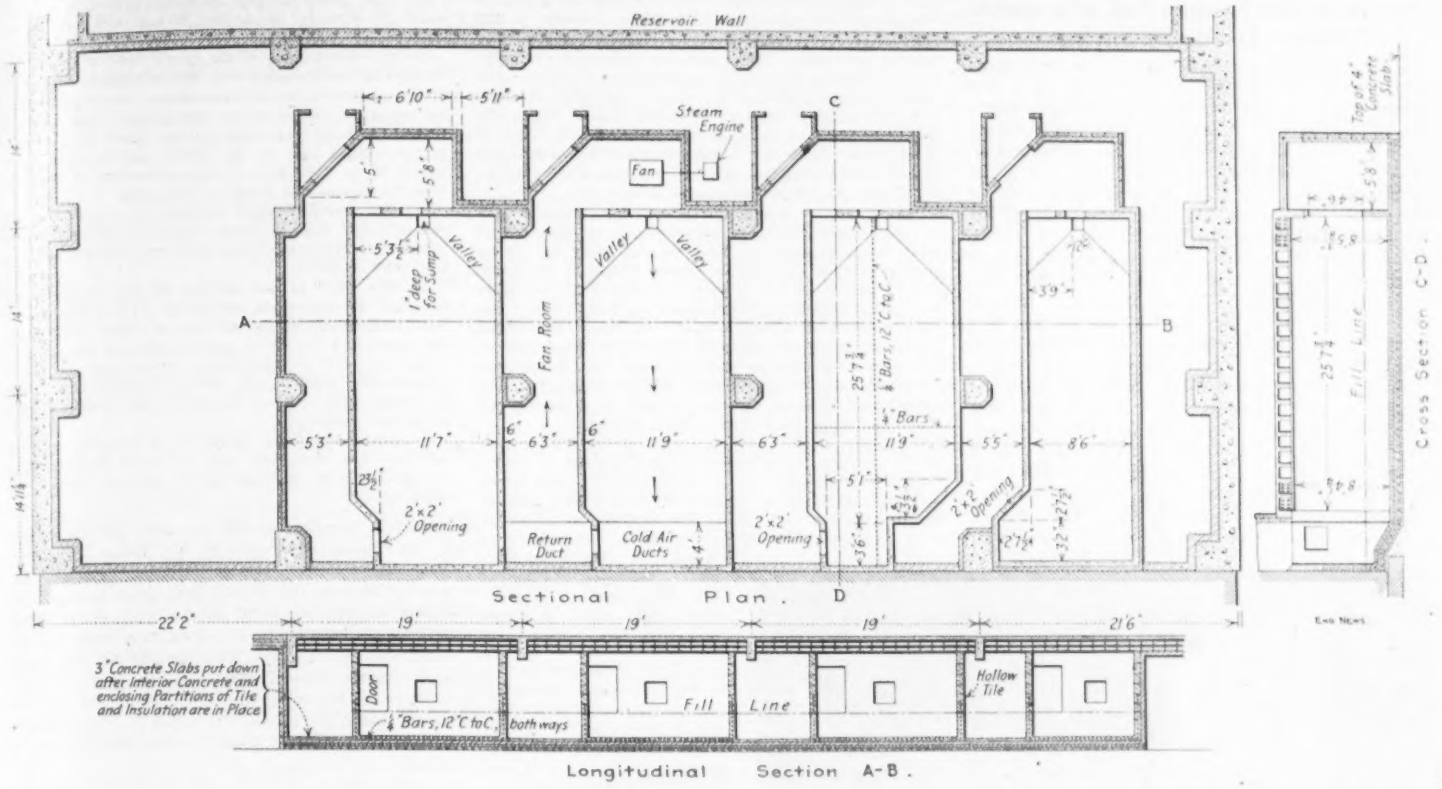


FIG. 2. BASEMENT DETAILS.

engine room in the old building. Air is forced through these chambers by large fans placed as indicated on Fig. 2, and cooled by contact with the brine-filled pipes, forced upwards through the cold air ducts to the cooling rooms and distributed by means of large galvanized iron ducts. The return galvanized iron ducts are located on each floor in what has been found to be the economical position, and the air which has exhausted its frigid qualities is taken in at these ducts and returned via the hollow tile vertical ducts adjacent to the party wall, to the fan room in the basement, where it is drawn through the fans and into the coil chambers as before.

The vertical air ducts were constructed of hollow tile, two thicknesses placed separately and a layer of Genasco roofing between.

The walls of the coil chambers were built in two sections; the 1 ft. 6 in. section was poured with the floor as noted before; the remainder of the walls, after the coils had been installed, were constructed of 6-in. hollow tile, plastered on each side with Portland cement mortar. This change in construction was made in order to give quicker and less expensive access to the coil chambers for repairs which could not be handled through the door opening.

The brick work began on top of the basement walls and entirely enclosed the building. The concrete work was built as a skeleton and two heavy anchors looked out from each exterior column to anchor the brick work at each floor line.

The inside face of the wall installation was plastered with Portland cement mortar. No difficulty was experienced in making the mortar adhere to the smooth surface of the slab cork.

The new building was designed for a practically uniform temperature, so the insulation of the intermediate floors was not necessary.

The exterior of the building was covered with a coat of paraffine applied under excessive heat and penetrating the brick work about ¾-in.

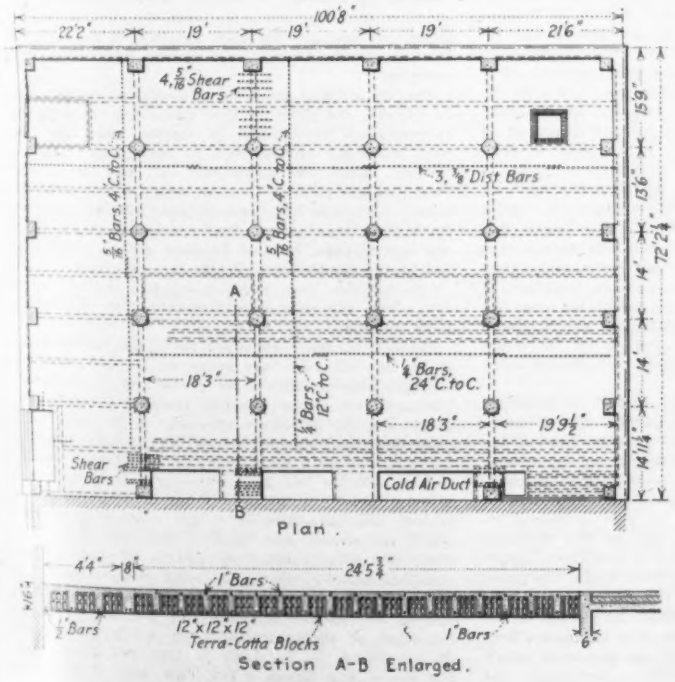


FIG. 3. FIRST FLOOR DETAILS.

The forms for the concrete work consisted of 2-in. dressed spruce for the beams and girders; ⅞-in. tongued-and-groove North Carolina pine for floor panels, and 1⅛-in. spruce for column forms.

Mr. J. G. Glover, of Brooklyn, was the architect; H. P. Kirkham & Son were general contractors; Turner Construction Co. had the contract for the concrete work and H. T. Weeks for the brick work.

LIABILITY OF CITY CONFINING FLOOD WATERS WITHIN BANKS OF STREAM.—An exception to the general rule that a riparian proprietor has no right to erect a levee or artificial bank along the margin of a stream, which will cause superabundant water, in time of ordinary floods, to flow upon or injure the lands of the opposite or other riparian proprietors, is presented in the recent Iowa case of Walters v. Marshalltown, 120 N. W. 1046, holding that a municipality which, acting under statutory authority and with ordinary skill and prudence, raises the grade of a street so as to confine flood water of a stream to the channel, is not liable for injury thereby inflicted upon lower riparian property by the increased flow of water over it. By the note accompanying this case in 26 L.R.A. (N.S.) 190, and which discusses the few earlier decisions upon the question, it appears that no authority has been found which directly supports the court in the decision.—From "Case and Comment," October, 1910.

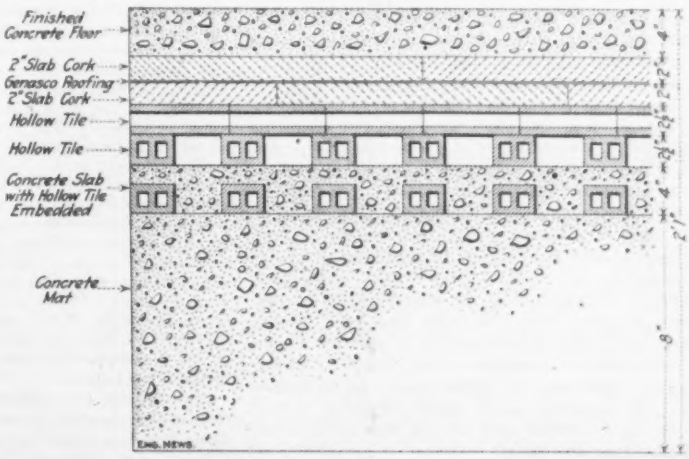


FIG. 4. DETAILS OF INSULATION UNDER COIL ROOMS.

Overheating and Pressure Test of a Jacobs-Shupert Locomotive Firebox.

A test has been made by the Atchison, Topeka & Santa Fe Ry. to determine the strength and behavior of a Jacobs-Shupert firebox under severe conditions of pressure and overheating, such as might be expected to cause an explosion with an ordinary firebox. This test was made at Topeka, Kan., on Sept. 26, and for a copy of the report upon it we are indebted to Mr. H. B. MacFarland, Engineer of Tests.

This type of firebox, which was described and illustrated in our issue of June 17, 1909, dispenses entirely with the use of staybolts. It consists of two shells (the firebox proper and the outside shell), each composed of pressed steel channels bent to approximately horseshoe shape to form the sides and crown. In both shells, the flanges of the channels are outward, and between the flanges of each adjacent pair of channels is riveted a diaphragm or stay plate which extends across the space between the shells (the water leg and steam space) and is slotted to permit ample freedom of circulation. The firebox which was tested had been in use (in stationary practice) since November, 1909. It was 109½ × 79½ ins. inside, its length being formed by 11 channels. The inner channels were 0.313-in. thick and the outer channels 0.5-in. The boiler was 77 ins. diameter in the smallest ring and 88 ins. at the first ring; it had 373 tubes 2¼ ins. outside diameter and 19½ ft. long. The tubes were welded to the firebox tube sheet by the oxy-acetylene process. The water space was about 580 cu. ft. and the steam space 142 cu. ft.; firebox heating surface, 265 sq. ft.; total heating surface, 4,363 sq. ft.; grate area, 60 sq. ft.

INTERIOR OF CROWN OF JACOBS-SHUPERT SECTIONAL FIREBOX AFTER TEST BY OVERHEATING.

(The light colored portions are the discolorations due to overheating of the steel channels of which the firebox is composed.)

The boiler was set up on the open, and was fired with oil. Water was supplied by a pump placed at some distance. Compressed air was piped to the tall iron smokestack to produce sufficient draft. Two pressure gages were used so that one might check the other, and an additional water gage was attached to the boiler head to indicate the level of the water relative to the top of the crown sheet. A lever was connected to the blow-out of the boiler, so that the water could be lowered, and this was operated from a point near the pump. The pop safety valves were set at 225 lbs., which is the normal working pressure of these boilers. Two pyrometer couples were inserted in the steam space, in the second channels from the front and back of the firebox, the leads extending to a shelter where the temperature readings were made. These showed the temperature of the crown on its steam side. Observations were made from a shield formed by a firebox laid on its side at a little distance from the boiler.

On the morning of the test the boiler had been fired up for some time previous to the test, and the pops were registering intermittently with boiler pressure at 225 lbs., as shown by gages recently calibrated and checked against test gages. The water was lowered in the boiler until it showed only 1 in. above the crown sheet. The water was then lowered by opening the blow-off valve until it was level with top of crown sheet. During the period of lowering of water the steam was blowing off continuously, and the boiler pressure was constantly maintained with such a usual fire in the firebox as results from the proper combustion of oil.

The water was then blown off to 4 ins. below the top of crown sheet in three minutes and at the rate of 1,210 lbs. per minute. Two minutes after the crown sheet was bare the firebox showed effects of expansion due to heating of crown sheet, by very slight openings in the stay sheets near the middle of the firebox. The leaks from these openings were very slight and would not be considered of any consequence in ordinary service. The reason for the opening of these stay sheets was on account of the construction, which allowed the stay sheets to be butted together instead of being formed from one piece as is the present practice.

The crown sheet heated gradually at an average rate of 67° per minute for a period of ten minutes, at which time the temperature of the front section of the crown sheet (as indicated by pyrometer) was 1,123°, that of the back section was 1,065°. The pressure, as shown by both gages, was 230 lbs., although all the pops were blowing off. The water level was 6 ins. below the top of the crown sheet. The steam from the pipe indicated soon after the crown sheet was bare that the crown was getting hot. Toward the end of the test, when practically all of the crown was bare and a large amount of hot metal was exposed, the steam shown from the blow-off was considerably superheated.

Ten minutes after the crown sheet was made bare and it had been heated to a temperature of 1,125°, signal was given to put on the pump, and water at 60° was forced into the boiler. The fire was cut off at this time, as it was not deemed advisable to continue a fire in the box with exposed crown sheet during the period of filling the boiler with cold water. Simultaneously with the injection of the water into the boiler the pressure dropped a few pounds, and the water fell in the lower gage glass so that it was not visible by observers.

Several witnesses approached the firebox when water was still 3 ins. below the crown sheet and observed that the crown was still red. In 8½ minutes after the pumps were started the water was at the crown sheet and the pressure at that time was 215 lbs. Within 15 minutes after close of test the interior of the firebox was inspected by George Austin, General Boiler Inspector; Frank W. Shupert, Boiler Foreman and Inspector; Gustave Mihleisen, Assistant Boiler Inspector; and John K. Nimmo, Boiler Inspector. They reported no distortion of sections nor opening of seams, but indications of an overheated crown sheet such that in a firebox of ordinary construction would cause a dangerous explosion.

RESULTS OF TEST.—As soon as the boiler was sufficiently cooled down the water was removed, the boiler dismantled and the fire pan removed. Three hours after the test had been concluded the boiler was turned over so that an opportunity was afforded for a more rigid and closer inspection to determine exact condition of firebox. Several photographs were taken to show the condition of the sections and that portion of the crown sheet overheated. The whitened portion of the crown shown in the accompanying cut shows that portion which was overheated during test.

Close examination of the sections showed no distortion whatever in any portion of the sections due to being overheated. There were no leaks between any of the sections and no flue leaks. An inspection of the interior of the boiler on top of the crown sheet showed the characteristic blue color that accompanies the overheating of a crown sheet. The intensity of the color increased towards the center of the sections, showing that the temperature of sections of the crown sheet was much higher at the central portion than at sections where the pyrometers were located.

DIRECTIONS AND CONCLUSIONS.—As a result of the test, in consideration of experience with locomotive fireboxes of ordinary construction, and the manner in which the test was conducted, the following deductions and conclusions are warranted:

(1) The Jacobs-Shupert sectional firebox is stronger than an ordinary locomotive firebox with sheets held together by staybolts.

(2) The overheating of the crown sheet of the Jacobs-Shupert sectional firebox does not decrease holding power of the stayplates and rivets, owing to protection afforded by being in retreat from the flames. The ordinary firebox, with its numerous staybolt heads fully exposed to the intense heat of the flames, has its strength reduced 65 to 75% due to the overheating of a crown sheet in case of low water in the boiler.

(3) The Jacobs-Shupert sectional firebox is not subject to undue stresses due to changes in temperature, on account of provision being made for free expansion of individual sections.

(4) The form of construction of the Jacobs-Shupert sectional fire-box gives protection from explosion and from consequent danger in case of water being below the crown and the crown sheet getting red hot.

(5) The form of construction is such that in case of rupture the firebox will not be entirely torn apart, as results with ordinary fireboxes, and thereby cause a dangerous explosion.

(6) The firebox was subject to a pressure, temperature and low water test such as would have caused a violent explosion in case of an ordinary firebox with staybolts.

With a pressure of 230 lbs. and the water level 6 ins. below the crown, the boiler conditions were as follows: steam, 337 cu. ft., 178 lbs.; water, 385 cu. ft., 20,651 lbs.; heat available as latent energy in total steam and water above 212°, 4,171,853 B. T. U.; total available energy, 3,245,700,000 ft.-lbs. The weight of the boiler and firebox was 75,000 lbs., so that "if total energy in boiler above 212° could be utilized, boiler would be raised 8.2 miles." The range of temperature and pressure during the test was as follows:

Time, a. m.	Temperature of crown sheet, degrees. Near front.	Near back.	Pressure, lbs. per sq. in.	Water below crown, ins.
6.43.....	440	395	225	4
6.45.....	540	495	225	4
6.46.....	740	630	225	4
6.48.....	860	845	225	5
6.50.....1,030		995	225	5½
6.51.....1,055		1,030	225	5½
6.52.....1,115		1,060	230	6
6.53.....1,125		1,065	230	6
7.03.....	...	...	212	..

THE CANADIAN TRANSCONTINENTAL RAILWAY includes the lines being built by the government from the Atlantic coast to Winnipeg and by the Grand Trunk Pacific Ry. from Winnipeg to the Pacific coast. With regard to the progress of the work on the Eastern Division (1,805 miles) from Moncton, N. B., to Winnipeg, about 1,250 miles of grading had been completed and 880 miles of track laid by Aug. 31. The whole distance is located and under contract and work is being energetically prosecuted on all contracts, with the exception of about 100 miles in the Province of Quebec, and 100 miles in the Province of Ontario. On these sections preparations are being made for work during next summer. These sections are probably the lightest on the whole line as regards grading, but involve some fairly heavy bridging.

The 880 miles of track above mentioned are distributed as follows: 250 miles in New Brunswick (which section is practically completed); in Quebec, about 200 miles west and some sections east of the Quebec Bridge; in Ontario, about 100 miles east and west of Cochrane (which is the point of junction with the Temiskaming & Northern Ontario Ry.), and the remainder eastward from Winnipeg. It is stated that the portion from Winnipeg east to Lake Superior Junction will be operated this fall by the Grand Trunk Pacific Ry., in conjunction with its branch from Lake Superior Junction to Fort William, Ont. This will give a third railway from Winnipeg to Lake Superior.

The construction work in general on this eastern portion of the line has been very heavy, on account of the high standard adopted and the low grades and light curvature. The maximum grades are 0.4% eastward and 0.6% westward, and the maximum curvature is 6°. Much difficulty has been experienced in finding solid bottom in many of the small lakes and muskegs through northern Ontario. There has been difficulty also along the St. Maurice River, in Quebec, owing to high water. No records were available as to the extreme elevation to which the stream was liable to rise, and parts of the line, after being constructed, had to be raised in some places as much as 15 ft., involving great expense. The bridge structures, while numberous and fairly heavy, present no remarkable engineering features. The most important of these structures are a viaduct at Little Salmon River, N. B., 4,000 ft. long and 200 ft. high; and one at Cap Rouge, a few miles west of the Quebec Bridge, 3,000 ft. long and 150 ft. high.

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Among the high honors in the scientific world to-day the John Fritz Medal is certainly one of the most prized. Instituted in 1902 by a number of friends of the veteran ironmaster of Pennsylvania as a tribute to his services to the iron and steel industry in particular and to the engineering profession in general, this medal is annually awarded "for notable scientific or industrial achievement" by a Board of 16, of which the membership is divided equally among the four great engineering societies. In spite of the fact that this Board is made up entirely of practising engineers, its awards during the five years from 1905 to 1909 seem to show that it was establishing a precedent to honor those men whose names are famous, not as engineers primarily, but as leaders in scientific development or in special fields of invention.

Quoting the awards as made, the medal of 1905 went to Lord Kelvin "for his work in cable telegraphy and other scientific attainments;" in 1906, to George Westinghouse "for the invention and development of the air-brake;" in 1907, to Alexander Graham Bell "for the invention and introduction of the telephone;" in 1908, to Thomas Alva Edison for the invention of the numerous devices which have made his name famous; in 1909, to Charles T. Porter "for his work in advancing the knowledge of steam engineering and in improvements in engine construction."

These names are all familiar to the engineering world, but, with the possible exception of the last, they are equally familiar to the world at large. Inventive genius and scientific attainment evidently had the preference over distinguished engineering achievements.

On account of this seeming precedent, then, it is of peculiar interest to note that the medal for the current year, as noted in our "Personals" column this week, has been awarded to Mr. Alfred Noble, Past-President, Am. Soc. C. E., "for notable achievements as a civil engineer."

In thus honoring Mr. Noble, the Board has honored the engineering profession, for his career has been that of the successful civil engineer. So far as we know, there is accorded to him no distinct invention which helped the industrial world, nor has he contributed to scientific knowledge by any particular discovery. Instead, he has through a period of 40 years led the active life of a civil engineer engaged in professional work solely.

Graduating from the University of Michigan in 1870, he spent the following 12 years in the Government engineering service, mostly on the lakes and canals of the Middle West. From 1882 until 1894 he specialized in bridge design and construction. Many of the Mississippi bridges which the late George S. Morison designed and built were under his immediate charge, and on the great Washington Arch over the Harlem River he was Resident Engineer. From 1895, when President Cleveland appointed him a member of the Nicaraguan Canal Commission, until 1909, when President Roosevelt named him as one of the Board of Consulting Engineers to examine into the present plans and construction of the Panama Canal, Mr. Noble has had perhaps the greatest experience on Isthmian canals projects and surveys of any American engineer. During this period he also was appointed a member of the U. S. Deep Waterways Commission of 1897, which presented the report upon the proposed ship canal from the Great Lakes to the Ocean. In addition to his service on the governmental commissions, Mr. Noble has practiced as a consulting engineer, and more recently has been Chief Engineer of the East River Division of the Pennsylvania Railroad's extensions into New York City, a work of sufficient magnitude to engage all of his time during the past five years. He has served as President of both the Western Society of Engineers and of the American Society of Civil Engineers.

Bearing in mind the facts that Mr. Fritz's eminence was gained, not by work as an inventor or a scientific investigator but in the practice of engineering, it seems highly appropriate that the medal named in his honor should be conferred upon one whose life has also been devoted to that practice.

The failure of the reinforced-concrete grain bin at Springfield, O., noted on another page of this issue, is another illustration that the need for education in the use and for warning as to the misuse of reinforced concrete is not yet passed. The omission of any reinforcing steel tying the straight walls to the cylindrical bins caused the concrete to shear as soon as the grain pressure in the interior rose high enough. Whether the omission of this steel was due to the designer or to the foreman in charge of construction, it is clear that someone on the work was absolutely ignorant of the stresses in the structure and the ability of the materials to withstand them.

And we may go one step further and ask whether it is good and commendable design in concrete elevator construction to add straight walls to the cylinders for the sake of utilizing the space exterior to the circular bins for additional storage. It is done commonly enough, we are well aware, but we question whether a real engineer would ever adopt such a construction of his own choice. We suspect that the reason why these straight walls are often added to circular bins is that some owner or manager *who doesn't know* (and who doesn't know that he doesn't know) issues orders that "economy" must be observed by utilizing the whole space for storage. So the engineer has to build a flat wall of reinforced concrete to sustain an internal bursting pressure which in not a few cases has proved greater than the wall could stand.

This is another example of the sort of penny-wise economy which an engineer often has to adopt against his will. For true economy in grain bin construction, or in other words for a structure of the least cost per bushel of capacity, one should adopt the circular bins and the space they enclose and leave the space on the exterior of the bins unfilled.

Turning again now to the Springfield elevator, its failure illustrates again the nonchalance with which concrete construction is still undertaken by inexpert men, notwithstanding the numerous accidents which have occurred.

Because concrete stands so much abuse it is assumed that anyone can undertake construction in it without knowledge of stresses or of the proportioning of material to withstand them. The person responsible for building those Springfield bins would not have undertaken to build a gas-engine or a 300-ft. truss bridge without some very definite ideas and practical experience in those types of engineering work. Why, then, did he take the responsibility for this elevator with the small knowledge of stresses which is shown by its failure?

Some of our readers may recall the very important paper on "Conservation of the Soil" contributed by Mr. James J. Hill to the Conservation Congress held at Washington in May, 1908, and published in our issue of May 21, in that year. Mr. Hill in that paper pointed out the steady and rapid reduction in the productiveness of American farms, and its portentous effect upon the available food supply of the world, and particularly of the United States.

The falling off in the yield of American farms is commonly ascribed to the exhaustion of the fertility of the soil. We find in "Science" for Oct. 21, however, a remarkable paper by Prof. H. L. Bolley, of the North Dakota Agricultural College. Prof. Bolley, as the result of much practical experience and extended experiments, declares that the falling off in the yield of cultivated lands is very frequently due, not to any lack of fertility in the soil, but to the developument in the soil of various parasites, fungi, etc., which sap the vitality of the growing crops and greatly reduce their yield. He illustrates this by flax, which, he says, is essentially a crop for new lands. As soon as two, three or four crops of flax are raised on land, the yield becomes so much reduced that the crop is no longer profitable. As an illustration of this, he states that during the last ten years the center of flaxseed production in the United States has moved westward over 200 miles. Taking the world at large, Prof. Bolley declares that only in the Netherlands, under the most intensive farming, has the flax crop remained a permanent one.

Regarding wheat also, he believes that large areas of the world's wheat fields are not depleted chemically, but rather contaminated with the diseases that wheat is heir to. One of the proofs which he gives of his theory is that seed wheat sterilized with formaldehyde will often give, when planted on the same soil on the same day, from 1½ to 4 bushels per acre greater yield than the same wheat not sterilized. He argues that this explains many things which have heretofore never been clear as to the reasons why crop rotation is essential to permanent farming.

One important conclusion which Prof. Bolley draws relates to the advantage of dry-land farming over farming in humid regions. One reason for the heavy crops raised under favorable conditions in the semi-arid regions is the fact that such soils are much less favorable to the growth of parasites and fungi.

The Conservation of Labor.

In a personal letter received from one of the American engineers who visited Europe this summer, a man who is a keen observer and a man of unusually broad outlook, the following paragraph occurs:

> I continue to be greatly impressed with the beneficent fraternalism of the German Government in many ways, and still hold the belief that Germany to-day is forging ahead faster and on a more substantial foundation for industrial progress and permanent greatness than any other country in the world.
>
> England has been wearing out its greatest of all assets, its working people, while Germany is conserving hers. This is a feature of the Conservation doctrine that should be preached more strongly in the United States.

The writer of the above letter puts the case strongly, but opinions similar to this are held, we know, by other American engineers who have become familiar with industrial conditions in Europe.

A remarkable illustration of the present condition of labor in England came under the observation of one of the editors of this journal during the past summer. There occurred in

August and September of this year a lock-out of the WOMEN CHAIN-MAKERS employed in the Cradley Heath district, not far from Birmingham. Strange as it may seem to those accustomed to American standards in the employment of labor, the chain-making industry in this district is carried on with female labor. It need hardly be said here that chain-making is a heavy, laborious and dirty class of blacksmith work. The Cradley Heath district where it is carried on is a part of England's notorious "Black Country," where the smoke from mills and furnaces constantly clouds the sky.

The condition of the female employees in this district became so serious some time ago that the government was appealed to for relief. Parliament has recently passed a law to check abuses in industries where employees are "sweated." Under this law a board may be created, made up of an equal number of employers and employees, with a chairman appointed by the government. It is the duty of this board to fix a minimum wage for the trade. The first case in which the act was put into operation was in the Cradley Heath chain-making industry. A board was created, as above described, and after seven weeks' deliberations it reported that the minimum wage for women employed at chain-working should not fall below 2½d. (5 cts.) per hour. The association of chain manufacturers was willing to pay this legal rate, but other employers outside the association attempted to compel their employees to sign agreements to work at a lower rate and refused to give out work to women who would not sign this. The result was a lock-out of 660 women.

It is fair to say that the condition of these employees excited widespread public sympathy in England. The Dean of Worcester issued an appeal for support for the locked-out women, in which he stated that 230 of them were unionists and 430 non-unionists, and that the non-unionists would hold out against the demands of the employers who insisted on a lower rate of wages than 5 cts. per hour *if 4s. a week could be raised to keep them from starvation.* The Dean very pertinently remarked at the close of a published appeal for support: "If the women are starved into submission at Cradley, it will make it difficult to remedy 'sweating' in any other industry."

The London "Times," a journal which has never been accused of any sympathetic attitude toward labor interests, published the testimony of a German traveler studying industrial conditions in various countries, who declared after a visit to Cradley Heath that neither in Japan, China, America or any other country had he seen anything so bad as the conditions prevailing in the chain-making industry.

It is needless to say how repugnant it is to American ideas to think of women working long hours under the worst possible surroundings at the lowest class of heavy blacksmith work; but, when we add to this condition the fact that the employers of these women are unwilling to pay so high a wage as 5 cts. per hour for the work, words are lacking for fitting comment upon the industrial condition of a nation where such a situation can exist.

Surely the above picture fully justifies the pregnant sentence in the letter quoted above: "England has been wearing out its greatest of all assets, its working people."

And now let us turn to the brighter side. Our correspondent says "Germany is conserving its working people." Without doubt, the most marvelous achievement of Germany for the benefit of its working people is its compulsory insurance against the calamities of sickness, accident and infirmity. The statistics have recently been published showing the results of government insurance in Germany for the year 1908. There was paid out during that year, in indemnity to wage-earners, the enormous sum of over $167,000,000. About half of this sum went for the maintenance of wage-earners during illness, and of the remainder, about $40,000,000 was paid to those suffering from accident, or their survivors, and about $45,000,000 for the support of the infirm. Even more impressive than these figures, however, are the figures giving the number of those receiving benefits during the calendar year. There were 5,700,000 persons received sick benefits, averaging about $14.50 each. Over 1,000,000 of those injured in accidents received indemnities averaging about $40 each, while 1,118,000 of the infirm were aided. The complete total, showing the payments, is given below. So far as we are aware, there is not a single qualified observer, who has studied the workings of the German system of providing for sickness, accident and old age among its industrial population, who does not agree that it is far superior to the system in force in any country. The detailed figures follow:

Insurance against.	Sickness.	Accident.	Infirmity.
Insured persons.....	13,189,600	23,674,000	15,226,000
male	9,880,540	14,795,400	10,554,000
female	3,309,060	8,878,600	4,672,000
Indemnity cases.....	3,701,180	1,008,677	1,118,749
Receipts: .....Marks	365,994,100	207,550,500	285,882,100
including contributions of employers.	114,913,900	181,596,600	92,211,200
including contributions of employed.	236,220,200	.....	92,211,200
Expenditure:	330,544,100	183,818,700	200,339,100
including cost of indemnity	331,049,900	157,884,700	181,476,800
including cost of administration	19,494,200	25,934,000	18,862,300
Total assets	267,708,400	326,601,500	1,489,610,600
Average indemnity per case ..[.....	58.07	158	165
Proportionate charge for insured.....	26.55	7.75	15.50

And now let us turn to the third pregnant statement in our correspondent's letter: "Care of the working people is a feature of the conservation doctrine that should be preached more strongly in the United States."

As many of our readers will recall, we have frequently called attention in these columns to the beneficent operation of the system of compensation for industrial accidents prevailing in all other manufacturing countries, and have urged that the United States should abolish its antiquated practice of placing the burden of accidents upon the employee.

The technical journal, however, while it reaches the engineers and managers, cannot reach or largely influence the great masses of the people. The nation owes a great debt to Ex-President Roosevelt for his forcible public advocacy, three years ago, of a reform of our antiquated employers' liability laws. It was this, undoubtedly, which gave the movement for reform a strong impetus in this country and has already resulted in legislation in the states of New York and Ohio, while a number of other states have commissions working upon new laws.

It is needless at this time to repeat the various arguments which prove that the burden of compensation to workmen injured in industrial accidents should be borne by the industry itself. That there are dangers in the change from existing laws, we are far from denying, but, as we have frequently urged, there are far greater dangers in standing still and opposing all reform.

On another page of this issue is printed a paper by Mr. William B. Dickson, First Vice-President of the United States Steel Corporation, entitled "The Betterment of Labor Conditions in the Steel Industry." This paper was read at the recent meeting of the American Iron and Steel Institute in New York City. It is highly significant that the author of this paper, who holds the position next to the highest in the greatest industrial corporation in the world, makes in his paper the following frank declaration:

> Personally, I believe that compensation to injured workmen is a legitimate charge against the cost of manufacture, and that the victim of an industrial accident, or his dependents, should receive compensation, not as an act of grace on the part of his employer, but as a right.

It is equally significant to record that the expression of this sentiment by Mr. Dickson in the meeting brought hearty applause from the members of the Institute, made up of the active heads of practically all the important iron and steel manufacturing companies in the United States.

It is well worth while to lay emphasis on another of Mr. Dickson's remarks, apropos of needed changes in our system of employer's liability laws. "It is much wiser," said Mr. Dickson, "to help steer an automobile than to get in front of it and be run down."

If the manufacturers and employers of the United States are willing to take up the question of employers' liability with as broa[d] ideas as those expressed by Mr. Dick[son] they can have a great influence in so shap[ing] legislation that the final result will be a b[enefit] to employers, to employees and, most of a[ll] to the general public. On the other hand, to merely oppose all efforts at reform of our a[nti]quated laws, or to attempt to defeat reform m[ove]ments by the corrupt methods which have [often] been made use of in the past, may d[elay] the change, but it cannot defeat it. Such op[posi]tion, however, can so antagonize the radical [ele]ment in the community that when legislati[on is] enacted it may be in a form which will pl[ace] most serious burdens upon American industry

The Letting of Contracts for the Tri-Borough Rapid Transit R. R. in New York City.

Bids were opened on Thursday last by the Public Service Commission of New York City for the construction of the principal sections of the so-called Tri-Borough Rapid Transit R. R. The contracts which were thus offered for public competition involve a larger outlay, it is probable, than any public work ever undertaken for which bids have been received at one time. The magnitude of this work, its public importance, and the long list of prominent contractors bidding upon it have caused us to take unusual space to place the bids fully on record in the present issue of Engineering News. The "Construction News Supplement" of this issue contains 20 pages in order to give us sufficient space to publish these bids in detail.

It seems worth while at this time also to explain in general terms what New York City has done in the past, and is now proposing to do, in connection with rapid transit underground railway construction.

The rapid transit subway now in operation in New York City was built under a very peculiar and unprecedented form of contract. Under that contract, the city furnished the money to build the subway and the contractor who undertook the construction agreed also to equip it and operate it for a term of years. When this contract was offered, the capital required was so great, and the uncertainties attendant upon the execution of the contract were also so great, that there was no competition to secure the contract and, in fact, none could reasonably have been expected. Contractors who were familiar with the work of construction and might have bid upon that were wholly unfamiliar with the business of railway operation.

Under these conditions the contract for the present subway went begging until finally a syndicate of capitalists undertook it. These capitalists proceeded at once to divide the subway work into sections sufficiently small so that any first rate contractor could undertake them. They let these contracts for construction on terms which gave them a large profit on their bid for construction.

During the time when this original subway contract was under construction, Engineering News repeatedly urged that New York should build its subway as the Boston subway was built—by going ahead and constructing it by letting contracts for the work in small sections under open competition. After completing the subway in this manner, the city could have leased it for operation as Boston leased its subway.

It should be said that Engineering News was not alone in holding these views as to the proper policy for subway construction at that time. Many of New York's leading men, including some of those most influential in connection with the rapid transit work, were in favor at that time of such a policy as we have outlined. It is probable that the late Abram S. Hewitt, more than any other one man, was responsible for the plan by which New York City turned over its credit to a private corporation which undertook the construction of the subway. Mr. Hewitt has been called "the father of rapid transit in New York City." He was a man of great ability, absolute honesty and devotion to what he believed to be the best interests of the city; but he had so

long followed the old school of political economy, which held as its corner-stone the idea that everything possible should be left to private enterprise and that governments, state or municipal, should do as little as possible, that he could not bring himself to the idea that New York could safely undertake the building of its own rapid transit system.

There have been great advances in public comprehension of municipal problems during the two decades since Mayor Hewitt framed his original plan for the loan of the city's credit to a private corporation. The public sentiment in favor of municipal activities is to-day unquestionably far stronger than it was then. Nevertheless, the old idea still persists, particularly in New York City, that private capital ought to be induced to furnish underground railways for the city. The difficulty is, however, that the capital involved is so large, and the risks and uncertainties to the private investor are so great, that no real competition can be expected when a franchise for subway construction is offered.

The Public Service Commission of New York City, in accordance with the terms of the present Rapid Transit Law, has opened the door to private capital. Bids were advertised for, to be opened Oct. 20, for the construction and operation of the Tri-Borough Rapid Transit Line in New York City by private capital. The bidder was to pay from the net earnings of the system the interest on the cost of construction, a dividend of a given percentage upon the stock of his company and the remaining profits were to be divided equally between the city and the company.

No bids, however, were received under this form of contract, and we believe that none could reasonably have been expected. The difference in the annual fixed charges upon the cost of such a subway system built with city bonds and built with bonds issued by a private company might be as much as a million dollars per annum. There are plenty of other reasons why it was not to be expected that a bidder would come forward with an offer to construct and operate these subway lines on terms advantageous to the city.

On Oct. 27, the Public Service Commission received bids from contractors for the construction of the principal sections of this subway, the city itself to pay for the work. There was no lack of bids this time. In fact, the contrast between the opening of bids on Oct. 20 and Oct. 27 was an object-lesson illustrating the difference between inviting bids from capitalists and inviting bids from contractors.

We attempt no comment at this time upon the plans or specifications for the work or the prospects of the new subway as a route which will draw a profitable traffic.* There has been, we are aware, more or less controversy over these questions. The point we wish to emphasize, however, is that the proper way for New York or any other city to build a subway is to follow the successful example of Boston. Let the city itself build its subway in a substantial, permanent manner and when completed lease it for operation on the best terms possible.

*The traffic record of New York's existing underground and elevated railways for the year ending June 30, 1910, has just been made public. The subway lines, about 25 miles in extent, carried 268,962,000 passengers. The Manhattan Elevated lines carried 293,862,000 passengers. Notwithstanding the high cost of the present subway, and consequent heavy fixed charges, the volume of traffic upon it is so great that the net earnings last year of the operating company were about 18% on $35,000,000 of stock.

LETTERS TO THE EDITOR.

The Irrigation of Farm Lands in Germany; "Views Afoot."

Sir: The question of the small scale irrigation of farm lands as practiced in the vicinity of Zermatt, Switzerland, has been touched upon in a recent issue of the News under date of Sept. 1, 1910, p. 223. The writer was much interested in this article from having visited the locality in question during the past summer, and ventures now to contribute a little further data along the same general lines; but with special reference to the hill country around Heidelberg where he has been spending a most enjoyable holiday, "tramping it" along the roads which lead from the Rhine up the valleys of many of its smaller tributaries.

I would speak particularly of the Ulfen Bach, a sizeable brook perhaps twenty miles long, whose watershed is situated largely in Hessen and Grossherzogthum, north of the river Neckar which passes through Heidelberg and joins the Rhine at Mannheim. The territory drained by the Ulfen in extremely hilly, even along its lower reaches, with the result that there are numerous difficulties connected with cultivating the soil, and although there is usually a well distributed rainfall, it is necessary to prevent the water flowing rapidly off the side hills into the brook, and to provide proper drainage for the low areas, quite limited in extent, lying close to the water's edge. There are very few manufacturing plants in this district so that the peasants in the numerous small villages are dependent for a livelihood entirely on the soil. Every acre of land not wooded is therefore made the most of, whether it be for potatoes and orchards on the upper slopes or for grass-land nearer the brook.

The soil, like the sandstone hereabouts, has a distinct reddish color when turned up by the plow, and water leaches out of it at various elevations all the way up to the wooded areas which cover the tops of the ridges. Instead of allowing this water to find its way directly into the brook through natural channels it is caught by small ditches running lengthwise of the valley along the contours, and thus distributed over as large an area as possible. The ditches at different elevations are connected one with another, in such a manner that the excess water not absorbed by the soil gradually works its way down into the stream at the bottom of the valley. Travellers on the road are seldom far from the sound of running water—the advantage of which is best appreciated by the man on foot who has a 20-lb. "Rücksack" swung to his shoulders. The ditches in places form a perfect net work over the fields, sometimes much like the veins of a leaf; but again without any evident system whatever. The low areas close to the stream are watered in a similar way, and in many places the ditches are fed not only from the sidehills, but also by means of a small canal which taps the brook some distance up stream and extends along the foot of the slope at the edge of the meadows. Drainage ditches are also provided, alternating with the irrigation channels, and it is common to find the water flowing freely in both sets at once.

Many of the meadows are dotted here and there with tall slender poplars, while diminutive willows are often seen growing in the ditches. A case comes to mind where one ditch had been carried over another in a crude trough cut out of a long shaft of solid rock. At a second place the cart path leading onto the meadow crossed the main irrigating canal on a small curved bridge, the supporting arches of which consisted of single pieces of rock cut to the required shape.

As a result of cutting up the surface of the land with ditches for irrigation and drainage the grass must be cut by hand, a rather slow process. The fields are not large, however, labor is cheap, and many of the slopes are so steep that it is difficult to operate even a small plow. During a week's tramp the writer saw but a single mowing-machine, a brand new one, receiving its first trial. On the other hand the careful watering and draining of the soil serves to keep the land a beautiful green in color all through the summer and well into October. The holding back of the water also makes the flow of the main brook more uniform, which means a good deal to the few mills that use the stream for power. One of the "natives" offered the information that it was possible to cut three or four crops of hay each year from the land close to the stream, while they never got less than two off the side hills.

It is indeed an interesting sight to watch a family of peasants at work in the field. The cutting of the hay is ordinarily done by the men; but the women and children, both old and young, take part in the raking, pitching and loading, while the "newest arrival" is very likely asleep in a basket close by, surrounded by some white nanny-goats or a flock of geese. The home-made hay-wagon, when full, is either pushed into town by the family or pulled by a span of cows hitched to the traces by their horns.

It might be mentioned that irrigation is used particularly for the orchards and mowing-land rather than for the potato-fields. A considerable portion of the main brook is, however, sometimes diverted above a village and carried close to the houses in an open channel, so that the water may be accessible for washing and other domestic purposes as well as for irrigating the small patches of grass found here and there along the highway in the center of the town.

It is well known that in Germany, as well as in France and Switzerland, the roads even out through the open country are of the best macadam and well graded. Every little while one passes a neat pile of finely crushed stone close by the roadside, to be used for repairs—not once in two or three years, but as often as is necessary. Some of the well traveled highways are provided with a gravel foot path at one side of the macadam, but not elevated to form a "sidewalk."

This suggests another use made of the water, or rather the street drainage which gets into the gutters along the sides of the road during rainy weather. Namely, the watering of the soil around the shade trees.

The shade trees which are spaced at intervals of about 25 ft. are planted by the township, or "Kreis" so-called, and in this district consist of apple, pear or cherry trees. The municipal employees who are constantly at work on each section of the road care for the trees (each of which is labelled in red paint with its number), and dig the small ditches leading from the edges of the highway towards the roots of the trees. The ditches have no outlets so that the water must either sink into the soil, overflow and run down the bank, or flow back into the gutter. They gradually fill up with sand and weeds and are cleaned out from time to time in connection with the work of trimming the edges of the grass bordering the road. Utilizing the surface wash in this manner has the effect also of keeping the grass bright and green.

When the fruit on the trees is ripe, it is sold by the Kreis to the highest bidder, who must attend to the work of picking. The trees are planted in such a way that every other one is considerably older than the two on each side of it. When they have outlived their usefulness it is a simple matter to replace the old ones with a younger growth, and there are usually some of the fruit-bearing age in place.

It is easy to imagine the pleasure one takes in travelling through such a country. A well shaded road free from dust, beautiful green fields on every side, and the sound of running water, all help in their way to make the day's journey thoroughly delightful, and we do not wonder that the German takes his vacation on foot and in the open country.

The care taken of the roads and the shade trees is perhaps one example of the many things done by a paternal government towards encouraging the development of the natural resources of the country by exercising a certain supervision over all phases of the industrial life of the people. And in the careful utilization of the water for irrigation and other purposes we get a glimpse of the thrift and economy which seems to be characteristic of this nation.

The factory employee in the large cities does not work in the attractive surroundings of the peasant; but he shows the same fondness for the green things of nature by the care he gives to the plants which brighten the windows of his home or to the truck garden that supplies so large a part of his provisions.

Chas. Saville.

Engineer, Einschergerwssenschaft, Essen, Germany, Oct. 5, 1910.

The Value of a Degree of Curvature.

Sir: In your issue of Aug. 25, 1910, p. 209, which I have only recently been able to look over, Mr. F. W. Harris asks for information in regard to the value of a degree of curvature. Although, as he states, there is a great diversity of opinion in regard to this matter, it seems to me that in so far as this affects the location of new lines, the differences are really of little moment when all the factors affecting location are taken into consideration.

The amount which might be spent to eliminate one degree of central angle for one daily train (one train each way), per year, was estimated by Mr. Wellington to be $8.66, assuming operating expenses to be $1.00 per train mile; with operating expenses at $1.50, which is probably nearer the average today, this would make the justifiable expenditure $13.00, which is practically the amount estimated by Webb.

In Bulletin 115 of the American Railway Engineering & Maintenance of Way Association, Mr. C. P. Howard discusses the question at some length, pointing out that while strict mathematical proof is not possible it is probably undoubtedly true that the value of a degree of central angle varies considerably under varying conditions and that "It is justifiable to spend more money per daily train to take out one degree of central angle on a fast line between New York and Chicago than on a slow speed coal branch in the mountains."

Mr. Howard proposes a formula which takes into consideration, the number of trains, cost per train mile, speed of trains and rate of interest at which money can be obtained, and shows that if his assumptions be correct the amount which may be spent per degree of central angle may vary between approximately $10 and $30 per daily train (one train each way). It is impossible to do more than indicate here briefly Mr. Howard's assumptions but to all interested in this subject a study of the proposition submitted by him in the Bulletin referred to cannot fail to be of interest, although as he frankly states, we have very little *definite* information on which to base any assumption, and owing to the nature of all the factors it may be a long time before we do.

Coming back now to actual practical location. It is probably well known now that I have always advocated proper technical and scientific methods but at the same time, true locating engineers are born and not made, only their natural intuition and "eye for country" must be supplemented by proper training and knowledge of operating conditions.

Mr. Howard cites an instance of revision where a very crooked line was rebuilt with very much better alinement and quotes a critic as stating in substance that the new line was a 6° line through a 16° country. Many of us have located lines with 0.5% grades through so called 1% country, but it has always seemed to me that given a certain amount of business in sight with reasonable provision for the future, a locating engineer, with proper experience and knowledge of what has been done elsewhere, will have a pretty fair idea of the kind of line which he ought to be able to get out of the country before him and then only needs a comparatively rough check on his work. If he, therefore, assumes a value for curvature anywhere between $15 and $20 per degree he cannot go very far wrong, as there are so many other uncertain quantities which affect the location, that great exactness in determining the value of curvature, distance, rise and fall, etc., is likely to be more than offset by other considerations.

The problems to be met in the location of new lines I have always considered to be very different from those affecting the revision of old ones. In the latter case, operating conditions and expenses can be determined with considerable exactitude and the character of the country readily determined by an inspection of the permanent way of the old line. For such work there is no question but that careful study should be made to determine as accurately as possible, values for all the operating factors, but even in this case as Mr. Howard states, it is difficult to reduce to a formula "the comfort of passengers, and the peace of mind of engine drivers and operating officials." It is always advisable to cut out all the curvature possible and it is surprising how much of this can be done without *any* added expense for construction if proper studies of the country are made.

Of course, all the above must be very unsatisfactory to those who believe that engineering should be an exact science rather than an art, but all engineers, of any extended experience, even those who dislike to admit it, know that there is a certain sense of the fitness of things, or intuition, if you please, without which all our scientific calculations are of little use. Mr. Howard's discussion is a thoughtful attempt to reduce what we know and what we surmise in regard to the operating cost of curvature to a formula, but while there are so many factors undetermined, we shall have to rely, to a large extent, on our sense of intuition, eye for country, or whatever it may be called, although, as I have frequently stated, this must be supplemented by experience in construction and operation, study and much hard work.

F. Lavis, M. Am. Soc. C. E.

50 Church St., New York City, Oct. 25, 1910.

The Study Hours of Engineering Students.

Sir: I have read with interest your editorial in Engineering News, Oct. 20, 1910, p. 419, upon the amount of work required of students in technical schools. Since the statements made are quite broad, I suppose that you have extensive data, possibly tabulated, in regard to the hours of recitation, field and office work together with the time expected in preparation at the technical schools of the United States. Such data published in the Engineering News would be instructive and valuable to all engaged in educational activities.

At least 1½ to 2 hours must be given to the preparation (study and meditation) of average engineering subjects, before a student is in condition to profit by a recitation and discussion which is to last an hour. If less time is given to preparation, the recitation period should be shortened. The writer believes that it is not the amount of time required for each subject that is in some cases burdensome but the fact that, at those institutions, too many subjects are carried simultaneously. It seems that from five to ten (!) different subjects carried during one week must make it impossible to generate enthusiasm or appreciation of the work undertaken. The time used to prepare for a recitation held once a week in an important subject must be used largely in orientation.

For several years, the members of the first year class in the Thayer School have recorded each day on record sheets the entire amount of time given to Thayer School work; this includes time given to study. The average time devoted to study for each hour spent in recitation is about 1.67 hours. The average time given to study is about 2 1-7 hours for each recitation, the recitations averaging about 1 1-3 hours apiece. But two, or at most three, subjects are taken simultaneously.

Men who soon are to enter engineering or business life can scarcely expect less than the minimum time of 7½ hours work during six days in the week as indicated in your editorial. The maximum average time mentioned, about 13 hours per day for six days in the week, would seem to be exceptional, although you may have data to the contrary. Such amount is surely excessive. The time recorded by the Thayer School students averages about 8 1-10 hours per day for six days in the week. The students appear alert, healthy, vigorous and interested in their work. Any one who becomes a "dull Jack" under such requirements has no place in the engineering or business world. There they will find much more exacting conditions.

Yours truly,

Charles A. Holden,
Professor of Civil Engineering,
Thayer School of Civil Engineering.

Hanover, N. H., Oct. 22, 1910.

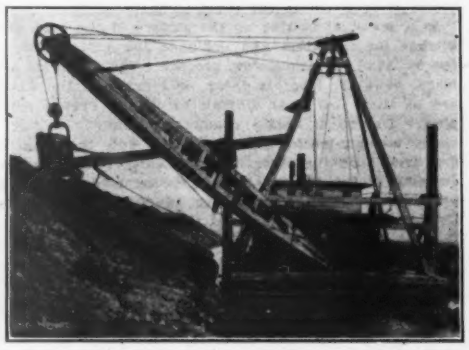
[An inspection of the catalogs of several well-known technical schools shows that, allowing a two to one ratio of study to recitation periods and counting lecture, laboratory, field and drawing-room work hour per hour, the minimum time required of a student will be about 48 hours per week. However, our impression is that the amount of time, outside of scheduled hours, spent on field and laboratory notes and on the solution of problems not included in the so-called "recitation" courses is nearly, if not fully, as great as that spent on preparation for recitations. We have no data to confirm this impression nor have we perfect faith in a student's recorded statement, for his professor, of the amount of study he puts on that professor's course.

We quite agree with Prof. Holden that too great a variety in studies breeds neglect of some of them, and we also admit that there are subjects where two hours of study will not suffice for a one-hour recitation, but, considering the probable congestion in recitation periods forced by the multiplicity of courses being given in the whole college, we doubt if a uniform two hours' study is put on each hour recitation. On the evening before a day with three recitations and a laboratory report to prepare, something is quite likely to suffer.—Ed.]

A Dipper-Dredge for a Railway Embankmemt.

Sir: It may be of interest to some of your readers to learn of the building of a large embankment from side-borrow on the Fraser Valley Branch of the Vancouver Power Co., across Sumas Prairie in the southern part of British Columbia.

The Fraser Valley Branch is a 60-mile electric line in the valley of the Fraser River, connecting New Westminster and Chilliwach and touching the international boundary at Huntingdon. There is nothing out of the ordinary in any of the construction with the exception of the three miles across Sumas Prairie about 15 miles from Chilliwach. This prairie is flooded every year by the back water from the Fraser during the June freshets so it was necessary to build an embankment three miles long and 17 ft. high to be above this flood water.



A 2½-yd. Dipper Dredge Building a 22-ft. Railway Embankment.

The contract was let Aug., 1909. The contractors used 3 cu. yd. drag scrapers operated from towers, the material being dumped between the towers and the borrow pit. While about 50% of the material was put in place this way the contractors were unable to complete the dump owing to the soft condition of the clay soil when mixed with water.

The contract was relet in April, 1910, to Ironside, Rannie, Campbell & Pike, of Vancouver, B. C., and they have successfully completed the work using floating dredges thereby handling the material as dry as possible. The accompanying half-tone shows one of the dredges at work where the top of the dump is 22 ft. above the water. The boom is 75 ft. long and the dipper has a capacity of 2½ cu. yds. This dredge has put up 2,000 cu. yds. per day of two 8-hr. shifts using four men to a shift. It was built by Mr. [illegible] N. Pike, of the contracting firm and the machinery was furnished by the Marion Steam Shovel Co., of Marion, [illegible].

Yours truly, F. N. [illegible],
Resident Engineer, Vancouver [illegible] Co.

Abbotsford, B. C., Sept. 28, 1910.

Allotments for Health Departments in Municipalities.

Sir: In an editorial in your issue of Oct. [illegible] you discuss the statistics of budget increase in New York City and comment on them as follows:

These figures suggest much in the way of comment, particularly as to why the increases in [illegible] primeval allotments should fall in just the order shown and why the health department should show an increase [illegible] our times as great as the growth in population and [illegible] that of the whole budget, while the police department [illegible] increase should be well under the population increase and not even half of the gross budget increase.

It seems to me that the question is very easily answered by the fact that the appropriation for health departments has everywhere been, and still is, absurdly small as compared with other municipal expenditures. This fact was forcibly brought out in the Chairman's address at the conference of Mayors of New York cities at Schenectady last June, in which it was pointed out that although the need for the protection of health is far more important than that for the protection of life and property, yet the appropriation for health usually lags far behind the others.

The reason for this is of course not far to seek as we all know. Fire departments put out fires and police departments arrest people, but a decade or so ago the health department did not save lives. The last ten years, however, have changed this and with the development of sanitary science which has made effective health departments possible, there ought to be a much greater proportionate increase in municipal appropriations for this purpose than has yet taken place.

Your editorial does not quote the actual figures, but from data made public in connection with the Budget Exhibit now going on, it appears that in 1900 the per capita appropriation for the protection of life and property was $5.72, increased in 1910 to $6.03. The appropriation for health purposes in 1900 was only $2.20, which in 1910 had increased to $3.51. This sort of increase must continue for some years more before the proper balance will have been reached.

Sincerely yours,

C.-E. A. Winslow,

College of the City of New York, Oct. 24, 1910.

Notes and Queries.

In "Excavation of Wallkill Pressure Tunnel, Catskill Aqueduct," pp. 406-410, Eng. News, Oct. 20, 1910, some errors in the map, Fig. 1 (p. 406), are noted. The following siphons, erroneously marked "Siphon Tunnels," are really steel-pipe siphons:

Foundry Brook Siphon, Indian Brook Siphon, Sprout Brook Siphon, Peekskill Siphon, Kensico Siphon, and Fort Hill Siphon.

An error in Fig. 7, p. 409, of the same article consisted in giving the thickness dimensions 13 ins. and 10 ins. to the C line. The correct dimensions should be referred to the A-line, and are: Inside finish to A-line, 10 ins.; A-line to B-line, 13 ins.

THE FREIGHT TERMINAL SYSTEM OF CHICAGO is hampered by the lack of effective interchange facilities and by the handling of local, through and interchange cars in the various local freight yards. A recent report by the Terminal Officials Association of Chicago makes the following statement in regard to these conditions:

The enormous increase in traffic has overtaxed the facilities. While the railways have added to their facilities, these improvements have not equaled the development of the traffic. In fact, the rapid building up of the city has made it impracticable in many instances for railways to extend their present terminals. Facilities in the elevated sections of Chicago, which were formerly available for freight traffic, are now needed urgently to take care of the immensely increased passenger and local freight business.

The necessity for relieving the downtown facilities of freight traffic is beyond dispute. Certain of the traffic, such as freighthouse business and carload business for patrons located in the downtown district, must necessarily use these overtaxed terminals and no relief can be looked for from this direction. Relief, therefore, must come from the shifting of the interchange traffic.

Statistics show that there are now being received in Chicago approximately 4,000,000 loaded cars a year, of which about 775,000 loads is business to points beyond Chicago. About an equal amount is interchange business destined to points within Chicago. It is apparent that relief from the crowded conditions in Chicago (not only now, but in the future) must be obtained by separating the interchange business moving through Chicago from the interchange business destined to local points within the city.

The inside yards of the city can now take care properly of not more than the interchange business destined to Chicago proper, and such yards should not be burdened with the business moving to points beyond Chicago. We recommend that all lines having interchange freight to deliver make a separation of through and local business and that they make their deliveries to connecting lines through channels that will keep these two classes of business separate.

A Contractor's Views on Some Phases of Pavement Construction and Maintenance.*

By GEORGE C. WARREN.†

I propose to show that the success or failure of a pavement is fully as likely to depend upon causes beyond the contractor's control, both preliminary to the construction of the pavement and subsequent to its completion, as to perfect or faulty workmanship or materials; although, when a pavement fails to sustain traffic, the public universally, and officials generally, attribute the result to a combination of inefficiency and poor material, for which the contractor is held responsible.

At the outset I believe we shall agree that water is the great enemy of pavements, and the most common cause of their undoing, even when blocks of sandstone or other comparatively soft stone are used. The only material that is not seriously injured by the destructive influence of excessive water is granite, and even that is injuriously affected.

The source of deterioration from water may be summarized as follows: (1) Improper sub-drainage. (2) Excessive sprinkling or flushing. (3) Lack of efficient cleaning. (4) Sub-drainage, due to the absence of pavements, or to their improper construction, between and around railroad tracks. (5) Too flat crown or grade to provide proper surface drainage.

All of these features are absolutely beyond the control of the contractor, yet they provide most fruitful sources of dispute between him and municipalities as to the responsibility for defects which develop subsequent to the expiration as well as during the maintenance periods of paving contracts.

SUB-DRAINAGE.—Perhaps there is no part of street pavement construction which is given so little intelligent consideration by engineers, or in which local custom is so blindly followed from decade to decade, as this matter of sub-drainage. And yet practically every writer on street pavement construction from John Macadam to the present day has referred to sub-drainage as the first essential to successful road or pavement construction. We find cities where the prevailing subsoil is clay, that affords inadequate natural drainage, providing no artificial drainage for their pavements. We find other cities where the subsoil is either sand or gravel, that affords the best possible natural drainage, providing for their pavements elaborate systems of sub-drainage that are of course wholly unnecessary. Again, we find cities adopting systems of sub-drainage in use in other cities where the subsoil, and, consequently, the artificial drainage requirements, are radically different.

In a certain city of Central New York, which I have had especial opportunity of studying during the past twenty-four years, the pavements have proved to be better than those in any other city of the United States or Canada which I have visited, although the subsoil is generally clay, the poorest medium for natural drainage. Apart from careful construction and selection of material used in the pavement, which have not been greater than the care shown in similar work in other cities where the results have been far less satisfactory, I attribute the unusual excellence of these pavements chiefly to the elimination of water, both from the under and upper surfaces. This has been accomplished by an efficient system of sub-drainage; and by thorough dry cleaning and entire absence of wetting down the dirt by excessive street sprinkling and flushing.

The system of sub-drainage in this case, which was adopted in the year 1886 and has been strictly adhered to since, is as follows:

(1) A trench 1 ft. wide is excavated under the curb to a depth of 3 ft. below the top, or 18 ins. below the bottom, of the curb.

(2) In the bottom of the trench is placed a narrow culled hemlock board for which other cheap lumber may be substituted, and the pavement side of the trench is boarded up with the same material, up to the bottom of the curb, to prevent the earth under the pavement, as it dries, from falling into the drain.

(3) On the board in the bottom of the trench is placed a line of 3-in. half-round porous tile, open at the bottom and with open joints.

(4) Over the tile the trench is filled to within 2 ins. of the bottom of the curb with hand-placed field or cobble stone, over which is spread a thin course of finely crushed stone, slate shale, or slag—fine enough to fill the chinks in the field stone at the surface but coarse enough not to run into and fill the spaces between the pieces of field stone.

(5) Over this is spread about an inch of loam or clay (not gravel or sand), which, when dry, will hold together and not sift into the drain.

(6) Over this curb is set in the usual way—if the curb is of stone, it is bedded in either gravel or concrete; and if the curb or gutter is of Wainwright or other Portland cement, it is laid directly over the drain. Of course the drains are connected with catch basins.

This method of construction is the best, most efficient, and most economical system of sub-drainage I have ever known. No cross drains have been necessary, although the natural drainage conditions are very poor.

Systems of surface drainage of which I thoroughly disapprove, either because of inefficiency or unnecessary expenses are those that include too shallow drains at the curb; and trenches filled with crushed stone in the center of the road with similar cross drains at intervals.

The cross drains tend to attract water from outside the roadway and carry it under and to the center of the pavement, where it percolates into the otherwise dry subsoil. This is not only an unnecessarily expensive system of sub-drainage, but one that is really less efficient than no drainage.

It may be set down as a fact that with any of the modern, nearly waterproof forms of pavement now in vogue, unless there are actual springs under the roadway (an extraordinary condition that requires extraordinary treatment), the subsoil under the pavement will be practically bone-dry if no water is allowed to percolate from back of the curb. To prevent this a drain having a depth of 3 ft. below the curb is all that is necessary. As indicated above, if the subsoil is gravel or sand, providing natural drainage, through which water percolates, no artificial drainage is necessary.

CAUSES OF FAILURE OF PAVEMENTS.—The most frequent causes of failure in pavement construction, all of them being entirely under the control of city officials, and just as entirely out of the control of the contractor, are as follows:

(1). Inefficient or no drainage. This was considered above in considerable detail.

(2). Improper back-filling of trenches.

(3). Insufficient crown and gutter grade to carry off water and prevent pools standing near the center and in the gutters of the roadway.

(4). Lack of cleanliness.

(5). Excessive flushing or sprinkling of streets.

(6). Inadequate pavements, or none at all, between and along railroad tracks.

WATERING AND CLEANING.—Recognizing that water is the enemy of all pavement surfaces, the effort of those engaged in the improvement of road-surfacing material of every kind is directed toward reducing the porosity of the roadway surfaces, and otherwise protecting them from the ravages of excessive wetting.

On the other hand, the efforts of some street cleaning interests are directed toward keeping the streets wet by various forms of sprinkling and flushing machines, without properly cleaning the surface of the pavements. Still other interests engaged in street cleaning advocate dry cleaning and are developing methods to accomplish their purpose. Their objects are feasible, but, pending the advent of machines that will efficiently and economically do the work, all municipalities should take a middle ground and follow one of the following courses:

(1). Thoroughly wash the pavements nightly, *without* pressure, using either a washing machine or fire hose, and immediately follow the washing with hand squeegees to remove all excess of water from the gutters and slight depressions.

(2). Sweep nightly with machines, *lightly* sprinkling the pavement in advance of the sweeper, and using enough water to lay the dust but not enough to convert it into mud—exactly as a dirty floor is cleaned by light sprinkling and hand sweeping.

No one would think of wetting a floor to such an extent as to convert the dust into mud, and then expect to remove the mud by sweeping. Yet the equivalent of this is done in most cities where the attempt is made to clean pavements by rotary brooms, immediately following a thorough wetting by sprinkling wagons. After such an operation is it any wonder that covered with water and earth or sand (a mixture that will sharpen and wear away the hardest steel) pavement surfaces are literally butchered by the grinding they receive from the wheels of the traffic.

Either of these methods specified, if carefully and properly applied, will provide a well-cleaned pavement surface which will require no sprinkling through the day, if hand-cleaned by patrol system by day. The adoption of such a system will insure a pavement that will always be in the best condition for horses, automobiles as well as pedestrians on the sidewalks, being free from dust and mud, and capable of sustaining traffic without deterioration.

TRACK CONSTRUCTION.—Railroad beds improperly constructed, or tracks poorly laid, are common sources of injury to pavements, and the damage will extend not for only a few feet from the rails, but sometimes across the entire width of road-bed. The same undesirable results are often produced by faulty contruction in the pavement itself between and along the rails. If the rails or the ties are not securely laid as to prevent vibration the pavement, whatever may be its construction or the material used, will be sure to break and allow water to work its way through and settle beneath the pavement. I have seen, in a number of cities, first-class pavements laid outside the track area, from the rail to curb, or from within two feet of the rail to the curb, while between and around the rails there would be absolutely no pavement at all. In such cases from 1 to 3 ins. of water will accumulate between the tracks during every heavy rainfall or spring thaw, and have no outlet except into and under the pavement; and if the pavement is not more or less destroyed it is only because Nature has provided conditions which permit the water to drain nearly vertically into and through the soil.

MAINTENANCE GUARANTEE.—Turning more specifically to the subject of pavement guarantees and maintenance, I am firmly of the opinion that pavement guarantees extending beyond a term of one year, which is ample to test the integrity of material and construction are against the best interests of the taxpayers. In support of this view I offer the following reasons:

(1). Guarantees are always of doubtful legality. On assessment work, which is the basis of payment for over 75% of the street pavements laid in the United States and Canada, the courts have frequently, if not generally declared maintenance guarantees to be illegal, because they provide for indirectly assessing abutting taxpayers for the cost of maintenance, which city charters usually say shall be paid for by the city at large.

(2). There is always likely to be more or less dispute between the contractor and the city regarding the contractor's obligations to make certain repairs, especially when the damage done can even remotely be attributed to causes such as those to which we have referred as lying outside the jurisdiction of the contractor, and, similar contentions will arise between the contractor and the city as to the extent of repairs and nicety of condition of maintenance of the pavement which is proper under the guarantee. It is not an exaggeration to say that under guarantees, cities generally endeavor to require contractors to make repairs to pavement surfaces that they would not think of making at the expense of the city.

(3). When guarantees for maintenance are required, prudent, conservative contractors always include in their bids the interest on the cash retained, and the cost of the surety company bond premiums required by the city, and a sufficient amount to cover a conservative estimate of maintenance charges. It has been calculated that if surety company bonds for five years' maintenance were required on all pavements laid in the United States and Canada, the premium, always added to the contractor's bid, would each year amount to more than a million dollars.

(4). Maintenance guarantees tend to produce lax inspection, or the loss of control of construction by the proper city officials, as the contractor in case of dispute or disagreement as to the methods of construction, will notify the city officials, that if he is not permitted to do the work in the way he thinks best he will not be responsible for the guarantee.

(5). Maintenance guarantees encourage the acceptance of proposals from incompetent or inexperienced contractors, and the selection of pavements of doubtful desirability. How often do we hear the statement made in connection with the awarding of street pavement contracts: "The contractor may not be reliable, or the pavement may not be successful, but we have the surety company bond, or the cash retained to back the five-year guarantee."

In twenty-five years' experience in the street paving business I have seen many paving contract guarantees defaulted, but I have never seen a pavement made good through a guarantee bond or a cash retainer, when the pavement or contractor failed, or when it was against the business interests of the contractor "to make good." There may be such cases, but if there are, they are usually the "exception which proves the rule."

GENERAL POLICY.—Finally, the best interest of the city in the construction of pavements will be conserved, *as it is in all other classes of construction*, by the adoption of the following policy:

(1). Decide upon the form of construction best suited for each particular case.

(2). Prepare careful plans and specifications for the work, and give the construction the closest and best expert inspection and supervision.

(3). Take entire responsibility for the results. In the long run this policy will produce better pavements, and at lower costs, than will the apparently attractive, but misleading maintenance guarantee system.

AN INLAND WATERWAY IN LOUISIANA, from New Orleans to Morgan City, is under consideration by a board of United States Engineers, of which Col. William T. Rossell is chairman. Surveys have been made, under the direction of Col. Beach, of the Corps of Engineers, for a canal 7 ft. deep and 75 ft. wide. At a hearing by the board at New Orleans, on Oct. 19, the construction of the canal was advocated as a means for local transportation in a region not well supplied with railway facilities and in which railway construction is difficult.

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*Slightly condensed from a paper read before the American Society of Engineering Contractors, St. Louis, Mo., September, 1910.

†Of Warren Bros. Co., 39 Temple Place, Boston, Mass.

Collapse of a Reinforced-Concrete Grain Bin at Springfield, Ohio.

A reinforced-concrete grain bin of a design somewhat typical in its main outlines but peculiarly dangerous in its details fell under a normal pressure of grain at Springfield, Ohio, on Oct. 24, 1910. We are unable at this time to present detailed drawings of the construction, but through the efforts of Mr. J. C. Lathrop, Assoc. M. Am. Soc. C. E., we are able to give here two views of the collapsed structure and some account of the accident. The elevator,

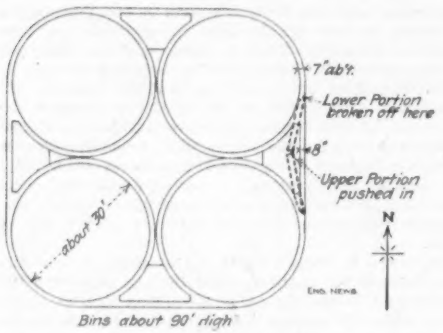

Fig. 1. Plan of Grain Elevator at Springfield, O., Showing Collapse of One Bin.

which was built for the Ansted-Burke Milling Co., has been in use for about two months. As shown in the plan, Fig. 1, it is about 60 ft. square, consisting of four circular bins, each about 30 ft. in diameter, and each having a capacity of 35,000 bushels, with five other bins formed by space between and around the circular bins, each of these smaller bins holding 6,000 bushels. We are not informed as to the reinforcement of the walls, except for that wall which fell, as described below.

About 9 o'clock on the morning of Oct. 24, when the easterly middle small bin held about 5,000 bushels of wheat, its outer wall failed, without warning, by the forcing outward of its lower portion. No one saw the beginning of the collapse, so its exact behavior cannot be stated, but from the present condition, as shown in Fig. 2, it is evident that the lower section of wall, where the pressure was highest was forced out under the pressure of the wheat, shearing off clean at the line where the straight wall connects with the circular walls of the two adjacent bins. The wheat rushing from the opening must have caused a partial vacuum at the upper part of the bin, and the outside air pressure forced the straight wall there *inwards*, cracking this wall at the middle, but not sufficiently to cause its fall. As indicated in Fig. 1, the bend there

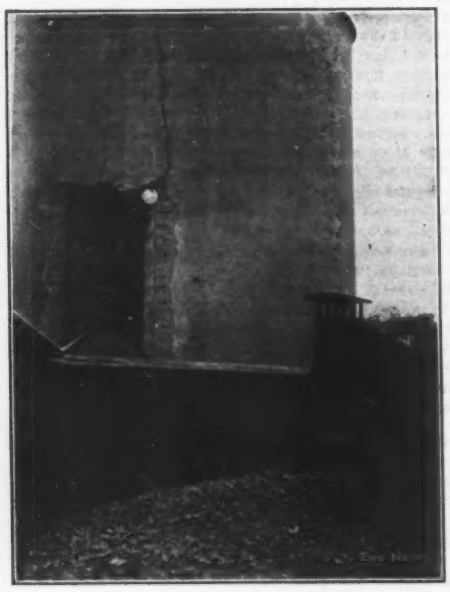

Fig. 2. View of Collapse.

is about one foot from the straight line. All the debris, together with the wheat, fell through the wooden roof of an adjoining shed, just missing a workman there, but not doing any further damage.

Observation of the structure by Mr. Lathrop the day after the collapse showed that the collapsed wall was 8 ins. thick, made of gravel concrete, and reinforced by ½-in. twisted rods, spaced horizontally on 4 and 6-in. centers, and vertically on about 3-ft. centers. The concrete was very hard and dense and amply sufficient to care for the stresses to which it should have been subjected. The weak point in the structure was that the horizontal rods in the straight wall were not connected in any way to the rods in the circular wall, nor were they tied back for any distance into the concrete of the circular walls. As shown in Fig. 3, the vertical break is perfectly clean, with no evidence whatsoever of any connection at that point. Many of the rods appear to be very close to the outer surface of the wall. This, of course, rendered the upper part of the wall very weak against the pressure from the outside, such as that to which the wall was subjected under the vacuum caused by the escaping wheat.

The bins were designed and built by the McDonald Engineering Co., of Chicago, and this company states that the plans showed the rods in these other walls securely fastened into the circular bins and that the failure to so fasten them was due to the negligence of the foreman.

It is also stated by some observers of the construction, but not confirmed by recent examination by Mr. Lathrop, that during the construction a piece of concrete some 8 ft. sq. fell out of this side wall immediately after the removal of the forms and that the opening was filled later with fresh concrete. In his examination of the wreck Mr. Lathrop could not find evidence of such repairs.

Chicago Rules for Measuring Excavation and Concrete Work.

The lack of definite or uniform rules governing the measurement of excavation and concrete construction in contract work in Chicago, and the disputes arising from this condition, led to the organization of a joint committee to prepare a set of rules for measurements of this kind. This committee was composed of 15 members, five each from the Western Society of Engineers, the Chicago Architects Business Association, and the Masons' and Contractors' Association of Chicago. The rules as formulated were approved and adopted by the three associations in June, 1910. They are given below, practically in full.

EXCAVATIONS OF CELLARS AND BASEMENTS.—Excavation to be measured and computed by the actual amount of material displaced. If unit price is based upon loose measurement add 40% to actual bank measurement, except if consisting of sand and gravel, when only 20% will be added. If rehandling becomes necessary, this to be done at a special price agreed upon in addition to the above.

EXCAVATION OF TRENCHES AND PITS.—Excavation of trenches, pier holes, or pits when more than 3 ft. wide to be computed on actual contents when less than 5 ft. deep. When less than 3 ft. wide, to be computed on actual contents if less than 2 ft. deep.

If more than 2 ft. deep compute contents of trench on base of 3 ft. width, even though same is narrower. If less than 2 ft. in depth, estimate actual width.

For pits or pier holes more than 2 ft. deep and less than 12 sq. ft. in area, estimate area of same on base of 12 sq. ft. multiplied by depth of same down to 5 ft. If more than 5 ft. deep, estimate on same basis as given below for additional depth of trenches, with the same percentage of increase added.

Depth, ft.	Add to actual contents, p.ct.
5 to 10	75
10 to 15	150
15 to 20	225

and so on, adding 75% accumulative for every 5 ft. additional depth.

BACKFILLING AND GRADING.—Soil required for backfilling or grading to be measured by computing from cross-sectioning cubic contents of area to be filled or graded.

SHEET PILING.—Sheet piling and lagging to be estimated per 1,000 ft. of lumber required. Kind of lumber to be specified.

SHORING.—Shoring of earth banks to be done at unit price per sq. ft. of shored surface of bank.

DRAINING.—Pumping or bailing to be done at special price, in addition to excavation unit price, as the excavation rules are based on dry work. This, however, does not apply to rain or storm water.

CONCRETE FOUNDATIONS.—Foundations for walls to be measured by actual contents when made with square and level offsets. For footings with beveled offsets less than 30% from the horizontal multiply area of base by greatest height of footing. This applies to piers, also, except when courses in pier foundations are less than 12 ft. in area, when 1 cu. ft. added for each corner for every foot in height of course.

Foundations for all projections such as chimney breasts, pilasters, buttresses, or flues connected with walls, to be measured actual contents thereof, and 1 cu. ft. added thereto for each corner for every foot in height.

Recesses and slots in foundations to be measured solid, and in addition thereto allow 2 cu. ft. for every foot in height of length.

Arches in foundations. Multiply length of chord at spring of arch by height from chord to extrados for thickness of arch, and add to the wall measurement of arch ring equal to thickness of wall.

Circular or polygon foundations to be figured double actual contents.

EXTERNAL, DIVISION AND INTERIOR CONCRETE WALLS.—For walls 14 ft. or less in height, 24 ins. or more in thickness, use the actual thickness as basis in computing the volume. For walls less than 24 ins. thick, add half the difference between the actual thickness and 24 ins. in computing the volume. If walls are more than 14 ft. in height between floors, add to cubic contents 15% for every additional 4 ft. in height on accumulative scale, as given for trench excavations.

CIRCULAR WALLS.—For circular walls of radius sufficiently large to obviate the necessity of using specially prepared lumber for forms, add 20% of length to girt of wall, and figure cubic contents on the same basis as prescribed for "External and Division Walls."

BATTERED WALLS.—For battered or sloping walls, estimate contents on same basis as for external and division walls, and add 50% of contents of wedge, or batter to same when narrower on top than 24 ins. (See also Corners).

INTERSECTION OF WALLS.—Intersection of division walls 24 ins. thick or less (bonded together in any manner not abutting) to be measured as slot or recess. When thicker, add 1 ft. to length of wall for every intersection when measuring.

RETAINING WALLS.—In retaining walls reinforced with beams, columns, or girders, figure concrete casing

Fig. 3. Near View of Broken Wall Showing Clean Break and Absence of Rod Connections.

a minimum thickness of 12 ins. from outside edge of steel on side next to earth bank and 6 ins. from outside edge of steel on opposite side; that is, compute wall 18 ins. thicker than width of steel.

For all other retaining walls compute on same basis as for external or internal walls. (See also Cornices). No deduction in cubic contents to be made for metal imbedded in wall.

HOLLOW TILES.—To be at special rates.

CORNERS.—For each corner of wall more or less than 90° add 18 ins. to girt length of walls in measuring. The term corner is used for salient angles of walls, and angle for re-entering angles.

PIERS.—Independent plain square piers to be measured by the same rule; i. e., add 1 cu. ft. for each corner for every foot in height. For plain polygon or round piers, add 4 cu. ft. for each foot in height.

RECESSES.—Recesses and slots to be measured solid, and in addition thereto allow 2 cu. ft. for every foot in height or length.

ARCHES.—In Vaults: Multiply length of chord at spring of arch by height from chord to extrados by thickness of arch.

In Walls: Find contents of arch by same rule and add same to wall measurement, as called for under foundations.

In Sewers and Tunnels: Multiply length of extrados by thickness of arch.

OPENINGS WITH FRAMES BUILT IN.—Deduct contents of windows, doors and other openings, measuring from jamb to jamb and from top of sill to spring of arch, and add 2 ft. of wall for each jamb for every foot in height of opening when plank frames are used. If box frames are used, add 4 ft. of wall for each jamb for every foot in height.

OPENINGS WITHOUT FRAMES.—Deduct contents of openings, same to be measured from top of sill to spring of arch and shortest distance between concrete jambs for width. Add for each jamb 2 ft. of wall for every foot in height of opening. Circular, oval or other special shaped openings to be figured at special price.

CHIMNEY BREASTS, FLUES AND PILASTERS.—All flues and hollows in chimneys or walls less than 2 ft.

in area figure solid and add 2 cu. ft. for every foot in height. Flues and hollows in chimneys or walls from 2 ft. to 4 ft. in area to be measured solid. When larger, deduct one-half of contents of flue.

Deduct all portions of chimneys in buildings and plain chimney tops above roof to be measured solid, and 1 cu. ft. to be added for each corner for every foot in height. Detached chimney stacks to be figured at special rates.

TRIMMINGS.—No deductions allowed for omissions of concrete for cut-stone, terra cotta or other trimmings, bond stones, timber, joists or lintels. All ornamental or molded work in cornices, gutters, belt or sill courses, etc., to be figured at special rates.

CUTTING AND PATCHING.—Cutting and patching of joists, girder, or other holes, slots, panels, recesses, etc., to be paid for on basis of time and material required.

TOOTHING.—When ordered to rack or block, in consequence of delay of delivery of iron, steel, stone, terra cotta, or other material, concrete work that may connect with such racking or blocking shall be measured as extra work, as follows: Increase girt length of such line by half, and multiply by thickness of wall.

CONCRETE FLOORS ON SOIL AND TILE ARCHES.—Floors to be measured by the superficial surface between outside walls of building. No deductions to be made for floor sleepers, conduits, pipes, drains, division or partition walls. No deduction to be made for any piers, columns, chimney breasts, pilasters or other projections of walls of 10 ft. or less in area.

CAISSONS.*—Owing to grillage in caissons being left at different heights in same building, unit price for caissons will be computed on excavated contents, including necessary wood lagging and rings for same. Cubic contents of excavation of caissons to be computed from top of first set of lagging to bottom of caissons and from outside to outside of lagging. If steel or other special casing is required, same to be paid for additional at special unit price per pound.

Area of bottom of bell to be multiplied by height of bell to neck for cubic contents.

For caissons 7 ft. or more in diameter, estimate actual contents from outside to outside of lagging. For smaller caissons add percentage to actual contents, as follows:

Diam., ft.	Add p. ct.
7 to 6½	5
6½ to 6	15
6 to 5½	25
5½ to 5	35
under 5	50

If compressed air is required, to be paid for in addition to the above.

If rings are ordered left in caissons, to be paid for additional at unit prices per pound.

Pumping and bulkheading to be paid for at additional price.

No deductions to be made for cubic contents of metal imbedded in concrete.

Concrete for filling caissons to be computed on actual contents per cubic foot of concrete, but no deduction to be made for any metal imbedded in same.

REINFORCED CONCRETE WORK.—Reinforced Walls: Compute concrete on same basis as specified for external and division walls, and add to same cost of reinforcing metal put in place. If (through changes or revisions) cutting of reinforcing metal delivered or ordered becomes necessary, estimate the full length of such bars or metal fabric and add to same the cost of cutting and fitting required. Reinforcing metal to be computed on unit price per pound or square foot. No deductions to be made in estimating cubic contents of concrete for any metal imbedded in same such as wire netting, expanded metal, bars, beams, columns, etc.

Columns: Measuring of plain uniform size columns to be covered by paragraph relating to piers.

Capitals, caps, brackets, panels, moldings or other ornamental or molded work to be figured at special rate.

GIRDERS, FLOOR BEAMS OR OTHER DROP PROJECTIONS BELOW FLOOR SLAB.—For projections named in this paragraph add for each corner and angle to cubic contents 1 cu. ft. for each foot in length. For each chamfered or rounded corner or angle add ½-cu. ft. for each foot in length in addition to the above.

FLOOR SLABS.—Floor and roof slabs to be estimated on same basis as floors or soil and at a minimum thickness of 6 ins.

OPENINGS.—No deductions to be made in floor area for openings of less than 20 sq. ft. For larger openings, after deducting full area of opening, add 1 sup. ft. to floor area for each foot in length of girt of opening, and 1 cu. ft. extra for each corner or angle.

DEPRESSIONS.—For pits, baskets or other depressions in floor, add 1 sup. ft. to the area of walls and floors of same for each foot in length of each corner and angle.

SETTING.—Setting of facias, frames, pipes, sleeves, bolts, rods, clamps, etc., imbedded in concrete to be paid for additional at special price.

FLOOR BASE AND COVES.—To be estimated at special price per lin. ft. with 1 ft. added to length of same for each corner and angle. For base or cove around round columns estimate three times girt of column, and for square or polygon columns add 1 ft. for each corner to girt of same.

Concrete stairs to be estimated at sq. ft. area of face of treads and risers. Stair-landings and platforms between floors to be same unit price per foot as stairs.

Curbs and roofs of skylights to be estimated on same basis as called for under girder projections and floor slabs, except that quantities of same shall be doubled.

Sidewalks laid on soil or tile and brick arches, to be estimated same as floor on soil, with special unit price. Sidewalks reinforced to be estimated same as called for under girder projections and floor slabs, in section with special unit price.

Curbs to be estimated per lin. ft., at special unit price.

Driveways to be estimated per sq. ft. area at special unit price.

THE MERCURY-ARC LAMP has been arranged with a fluorescent reflector to correct its abnormal color values by its inventor, Mr. Peter Cooper Hewitt, of New York City. The reflector consists of a hood having a white surface of some dull enamel to give a diffused reflection and coated with a film of the fluorescent material, which may be a rhodamine, dye carried in a cellulose binder. It has been known for some time, of course that rhodamine fluoresces with a ruddy light when subjected to the higher wave lengths of light, such as given off by the mercury arc tube.

*In Chicago the term caisson is given to a well or shaft sunk to hard-pan or rock, to be filled with concrete to form a foundation pier. In some cases they are enlarged or belled at the bottom.—Ed.

Annual Convention of the Illuminating Engineering Society.

The fourth annual convention of the Illuminating Engineering Society was held at Baltimore, Md., on Oct. 24 and 25, at Johns Hopkins University. The holding of the convention in this city and with this institution was fixed as a fitting opening of a series of 34 lectures on the art and science of illuminating engineering, given under the joint auspices of the university and the society. These lectures were noted in Engineering News, June 2, 1910, p. 659, as being intended for instruction of engineers generally in the principles and opinions comprising the science and art of good lighting, as presented by men of recognized prominence in the several related lines.

The convention program contained all the usual entertainment features—automobile and trolley trips and a luncheon for the guests, a reception and a banquet. The public was not forgotten either, and a lecture was given especially for them.

The opening session was largely given over to routine affairs, addresses of welcome by the Mayor of Baltimore, Hon. J. B. Mahool, and the President of Johns Hopkins, Dr. Ira Remsen.

At this session the presidential address "The Goal of Illuminating Engineering" was read by Dr. E. P. Hyde, of Cleveland, Ohio. This was an attempt to express in general terms the end sought by those calling themselves "illuminating engineers." The science of lighting lay in the principles of computation of desired illumination; the art lay in the relating of lighting to color, form and physiological effects. The goal was a happy combination of science and art that would give the most efficient lighting consistent with comfortable vision and harmony with fixed standards of architecture and decoration.

The Committee on Nomenclature Standards reported through a Sub-Committee on Photometric Units, Dr. C. H. Sharp, Electrical Testing Laboratories, New York City, Chairman. This committee presented, for discussion, a progress report outlining a proposed system of definitions of units and magnitudes. These were based on the international unit of candle power, and Prof. Andre Blondel's definitions of unit flux, unit intensity of source, unit illumination, etc. The several quantities depending on units of length were defined in English and in metric measure.

The chairman of the Committee on Division of Membership made an oral report, outlining the history of the movement to group and classify its members according to work, interests or specific attainment. The final conclusion reached was the momentous one "that a division of membership was advisable, when and in such manner as the membership at large saw fit." How this finding cleared the atmosphere of befogging discussion that has accompanied the question for the two years of its existence was not shown. After a long debate the report was "accepted" and the committee discharged, without committing the society in any way for or against division or classification.

At the following sessions eleven papers were presented, of which seven directly related to lighting and four were more fittingly described as commercial, as will be seen.

TECHNICAL PAPERS.—One of the most interesting papers presented during the convention, though, perhaps, the one of least practical value was "The Effect of Light on the Movement of Lower Organisms," by Prof. S. O. Mast, of Baltimore. He outlined in the briefest possible way how light has a very powerful effect on every living organism—how it broke down the complex structure of some bacteria to simpler chemical compounds, causing death, and how synthesis was possible as in the case of elementary plant growths secreting chlorophyl. Such growths have been found to segregate in groups where the light is of such intensity as best permit the vital processes. A single example of the action of the simplest animal organisms was described more in detail. The animal described seemed to be of the order Euglanina, a tapering rod-shaped microscopic mass of protoplasm marked by a small pigment spot near one end (the "eye"). These bodies were described as orienting themselves with the light rays, the "eye" facing the source. A position was sought where the intensity of illumination of the liquid residence was neither greater nor less than an optimum value.

In "Illuminating Engineering Sheets For the Calculation and Recording of Data," Mr. J. S. Codman, of Boston, Mass., showed two printed forms designed (1) to serve to conveniently record results of photometric tests of lamps as designed for commercial use, (2) to facilitate the illumination computations where the lamps are to be used, and (3) to form a convenient record of the above, preventing duplications of work. One sheet showed values of candle power, normal and horizontal illumination and allied quantities for various angles from a perpendicular through the lamp. On the other type of sheet these values were to be worked out for values of the tangent of vertical angle. Both sheets are printed with all the necessary mathematical data for the computations, so that recourse to tables of any kind was unnecessary.

In "Neglected Considerations of Street Illumination," Mr. P. S. Millar, Electrical Testing Laboratories, of New York City, discussed (1) the effect of objects being silhouetted against the lighter roadway, and (2) the effect of direct glare from light sources. It was held that objects in the streets, especially as seen by the driver of a vehicle, at night are most unusually discerned as silhouettes and that on that account the first requirement of good street lighting is the brightness of the roadway as seen viewing the street longitudinally at an angle of 2° or 3°. This brightness was to be increased by increasing the number of powerful lighting sources, and by using paving material having greater reflecting qualities. Nonuniformity of illumination between lamps was held to be far less objectionable than commonly believed, as it had been found that this "effective brightness" from specularly reflected light did not vary as much as the incident light, and that the brighter spots near the lamps, when viewed at very small angles, assisted discernment by silhouettes. Another effect of street lamps was given great consideration—that of the glare which might accompany the use of powerful sources. Its effect was found to be great and persisting in preventing discernment when the object viewed was within 5° of a bright and powerful light source or where there was no bright background. It was held that while a system could usually be designed to prevent undue glare and to increase city-pavement reflection, yet under most commercial conditions some compromise between glare and this "effective brightness" of roadway was best.

Naturally, these novel views aroused some contention from the advocates of more light and more uniform light throughout the length of streets and from those who believed that reduction of glare is all important.

"Relations Between Pressure and Light Output with Various Gas Lamps and Burners," was presented by Mr. Norman Macbeth, of The Welsbach Co. A series of representative open-flame and incandescent-mantle lamps were tested on a given gas at pressures varying from 2 to 8 ins. (of water) to determine the effect on candle power and consumption. The open-flame burners were, of course, capable of no adjustment and gave best results at the lower pressures. The actions of the flame at the high pressures were so peculiar and violent that the users naturally would reduce pressure by turning the fixture cock. The mantle lamps were adjusted at each change of pressure to secure the most light, as judged by the eye, and it was found that the light production, gas consumption and efficiency went up with increased pressures. The action was attributed to securing a better gas-air mixture before combustion.

"Some Spectral Luminosity Curves Obtained by Flicker and Brightness-Equality Photometers" was the title of a paper by Dr. H. E. Ives, of the Physical Laboratory of the National Electric Lamp Association, Cleveland, Ohio. This showed a few results of an investigation under way into the comparison of intensity of light flux of different colors—the problems of heterochromatic

photometry. Two common methods were compared, (1) using the common or brightness-equality photometer in which two areas (lighted respectively by the light sources being measured) are directly compared, and (2) using the flicker photometer in which light from the two sources is alternately thrown upon the viewed screen. In the latter method it will be recalled that when the illuminations due to each lamp are of equal brightness flicker disappears at low rates of change and the intensity of one source can be expressed in terms of the other, knowing the respective distances from the viewed screen. The studies in question were made comparing a white light source with definite monochromatic light obtained through a spectroscope. The flicker method was found of greater sensibility. Spectral-luminosity curves (showing intensity of light flux at different color points in the spectrum) did not show exact agreement between the two methods, the curves obtained in the equality-brightness method being shifted towards the blue or the flicker-method curves toward the red end of the spectrum. The author believed that the flicker method would become widely used but that it would need to be used by experienced men, and that the mean value of many observations by many operators would be needed to remove personal error. This would put such work onto the standardizing laboratory, which might evolve some comparison apparatus, or method, that would make it unnecessary to compare different colored light sources in commercial laboratories.

In a "Report of Progress on Flame Standards," by Messrs. E. B. Rosa and E. C. Crittenden, of the U. S. Bureau of Standards, Washington, D. C., were the results of studies into the variations of the Hefner amyl-acetate and Harcourt pentane lamps as primary standards of candle power. Variations of 2% had been noted in Hefner lamps reproduced from specifications and these variations were traced to lack of complete definition at points in the specifications, as for type of flame gage, thickness and specific heat conductivity of the metal of the wick tubes, etc. Differences of as much as 2 or 3% were obtained on different Harcourt pentane lamps built according to standard specifications and these were traced to lack of exactness in the specifications relating to the burner chimney, draft tube and a few details of construction. A correction for the effect of humidity in the air furnished has been derived differing from the accepted English figures by — 7.4% (0.57% change of candle power per liter water vapor per cubic meter of air in place of 0.60%).

In "Temperature Rise Due to Energy Radiation from Light Sources," Messrs J. G. Felton and E. J. Brady, with the United Gas Improvement Co., Philadelphia, reported on some bolometer measurements to find the intensity of radiations, appearing as heat, at different points of the lower hemisphere about gas and electric lamps. The curves of temperature rise and candle power for the common gas and electric lamps in the main agreed closely in shape and position, but there were wider variations in the ratio of candle power to temperature rise in the different directions.

COMMERCIAL PAPERS.—The paper "Illuminating Engineering Department Work and Methods of the Denver Gas and Electric Co.," by Mr. C. F. Oehlmann, stated that this company employs an illuminating engineer and an assistant, for services given to customers free as a part of the effort to give good service and to hold and gain consumers. This department specifies the amount and character of illumination, number of openings or units, does some architectural drawing, fixture designing, and keeps watch of consumers' complaints and wants. Another important work is in the instruction of commercial representatives, who have to deal quickly with the smaller installations, in the principles of good lighting, fixture design, etc.

In the discussion of this paper, Prof. Sidney W. Ashe, of the Brooklyn Polytechnic Institute, Brooklyn, N. Y., outlined the educational work in illuminating engineering being done at the Harrison Lamp Works of the General Electric Co. This work takes several forms: (1) training college men in the principles of illuminating engineering and salesmanship, as a part of their shop apprenticeship; (2) instructing prospective salesmen in the rudiments of electricity and lighting; (3) advanced courses once a year for salesmen so that they may be better able to give lectures and perform public experiments; (4) training a corps of experienced men to be retained at the works as specialists in various subjects like sign, street, residence, store or vehicle lighting; (5) experimental lecture courses, for factory and office forces, in elementary ideas about electricity and illumination.

There were also three short papers on the good that would result to an electric or gas illuminating company, or to the maker of lighting fixtures, in having all the designers, salesmen, etc., at least fairly familiar with the common facts and simple ideas behind good and efficient lighting. These papers were: (1) "The Value of Illuminating Engineering to the Manufacturer," by Mr. V. R. Lansingh, of New York City; (2) "Practical Value of Illuminating Engineering to the Central Station," by Mr. J. Gilchrist, of Chicago; (3) "The Value of Illuminating Engineering to the Commercial Man," by Mr. W. J. Serrill, of Philadelphia.

The Electric Bolt Lock as Applied to Interlocking.*

The mechanism of a mechanically interlocked switch consists of a means of throwing the switch, a means of locking it in both positions, and a means of indicating its position. The weakest point is the bolt lock; it is cumbersome and expensive to apply to any but a few switches in a route. Without bolt lock we must depend upon the facing-point lock altogether, with the result that our trust may be betrayed in a number of ways. Pins work out, despite cotter keys and other checks. The cranks and compensators can work loose from their foundations, or the foundations may move.

Any one of these causes can so bring it about that a switch will not respond to its lever, thus allowing the lock plunger to re-enter the hole in the lock rod from which it was withdrawn, or the switch may not complete its stroke and cause a break in the facing-point lock connections, or a loose part may allow the lock lever to be thrown. In any event the signalman has no intimation that anything is wrong. The lock rod or plunger or any other part of the mechanism can be removed, as in making repairs, and the working of the levers is not affected. In other words, nearly any failure through breakage, removal of a part, or by reason of lost motion is what is known in block signal practice as a clear failure; it is not on the side of safety.

It is possible to provide a reliable check on the working of a mechanically interlocked switch. In one system of electric interlocking, a device is used by which the switch must be fully thrown and locked before an indication is received at the lever. If the plunger re-enters the hole from which it was withdrawn, i.e., if the lock rod does not move, no indication will be received at the lever. If any part is removed (as the lock rod or plunger), no indication will be received at the lever. This is accomplished by making the stroke of the indication controlling contacts dependent upon the movement of the lock rod itself through its full stroke and of the movement of the plunger through the hole in the lock rod. The end of the plunger after having passed through the hole, completes the stroke of the controller.

To make protection complete, it is necessary: (1) to make the governing signal, when clear, lock the switch, and (2) to make the switch, when unlocked, place and hold the signal in the stop position. In other words, the presence or absence of any part of the switch locking apparatus, as well as its proper movement together with that of the points, should be detected. In addition, a device should be provided to hold such apparatus in its final position.

These safeguards may properly be called an electric bolt lock and they can be easily applied to a mechanically interlocked switch.

One method of application would be to provide an electric lock on the signal lever to lock the latch down with the lever normal and the lock de-energised. The circuit for the lock would pass through two controllers, one actuated by the locking plunger and one by the lock rod itself.

The controller actuated by the plunger should be carried on the dog of an electric lock situated at the switch, and so arranged that when de-energized the dog will drop into a notch in the end of the locking plunger, when the plunger is in locking position, and close the circuit when in this position only. When raised out of the notch or when dropped below it, due to the absence of the plunger, the circuit should be open.

The circuit for this lock should be through a normally closed controller on the signal arm, normally closed controller on the signal lever latch, and controller on the latch of the switch lever, so arranged as to be closed only with the latch up, but to be open with the latch down and the lever in either position. With this arrangement the operation would be as follows:

In lifting the latch of the switch lever the circuit for the electric lock on the plunger would be energized, raising the dog from the notch and releasing the plunger. This would open the circuit on the signal lever lock at this point, it being already open at the controller on the lock rod. The switch could now be thrown, closing the circuit of the signal lever lock through the controller on the lock rod. At the end of the stroke, the latch being lowered would open the circuit of the plunger lock, allow the dog to drop into the notch, close the circuit of the signal lock through the contacts on the dog, and release the signal lever. Clearing of the signal would open the circuit of the plunger lock both at the lever and blade, thereby holding the plunger in place.

Any failure of any part of the apparatus would prevent the movement of one of the levers concerned, thereby instantly calling attention to the fact that something was wrong. Absence of the plunger or lock rod would have the same effect. In the case of power operated or slotted signals the lock on the signal lever might be omitted and the signal circuit taken through the controllers as described for the lock circuit. The reason for making the lock at the switch act on the plunger rather than on the lock rod or some other part is that there is no strain on the plunger, consequently the dog would not be likely to jam. Also, it is desirable to detect the presence or absence of the plunger. Cross protection could be afforded by shunting the lock circuit to common whenever the former is broken.

One great advantage of the above described apparatus would lie in its adaptability to electric detector locking. All the locks on switches in a single route or section of route could be combined on one circuit and be actuated by the latch on a route or key lever, or by a floor push, thus minimizing the amount of electrical apparatus needed in tower, and the combined control circuit could be taken through the point of a track relay. Thus the presence of a train in the section would lock the plungers of the switches themselves, which is the theoretically correct method.

It would, no doubt, be exceedingly expensive to equip all signal levers with electric locks. But by suitable mechanical locking, a key lever could be provided (with lock attached to it) which would have to be reversed before any signal could be cleared. In that case more protection would be afforded than is now had when dwarf and low speed signals are rarely bolt locked. As a matter of fact, even high speed signals are often bolt locked only with such facing points as occur between the signal and the tower, and when power signals are used there is no equivalent of the bolt lock at all (a switch box merely controls the signal, it does not lock the switch).

With this system, a switch could be operated and locked by one pipe line if desired, so that in many cases there would be an actual saving by doing away with the separate facing-point lock. There would be fewer levers, with their attendant connections between the tower and switches. Thus there would be economy of levers, pipe line and tower room. The saving probably would be comparatively small, however, as it is safe to say that the cost of the electrical apparatus would equal that of the mechanical material displaced. Perhaps there would be a saving of money in the size of tower needed in large plants. However, in view of the added safety and reliability secured, even an additional expenditure would seem warranted.

There is still another factor to consider, namely, operation. By concentration, fewer levers are needed for any given route, consequently fewer movements are required to set up a route. This would result in economy of time, which is frequently an important matter.

By adopting some such arrangement of apparatus as above suggested the following results would be gained at probably no additional cost over present practice: (1) Failure would be on the side of safety. (2) Mutual locking between all switches and signals in a route would be secured. (3) Failure would be promptly detected. (4) Electric detector locking could be applied at the vital point, that is, the locking plunger of the switch. (5) Fewer levers and their connections might be required, resulting in, (6) Economy of time in setting up routes, thus facilitating train movements.

It is equally advisable to apply a similar device to power interlocked switches, and in all cases the apparatus should operate on plunger and lock rather than on any other piece of control apparatus. The plunger and the lock rod are the vital points and if they are held secure, and their presence or absence detected, a switch will be as safe as it is possible to make it.

*From the report of the Committee on Power Interlocking, presented at the annual meeting of the Railway Signal Association, at Richmond, Va., Oct. 11 to 13.

Betterment of Labor Conditions in the Steel Industry.*

By WILLIAM B. DICKSON.†

No man who has had experience in the employment of large numbers of workmen, and least of all, iron and steel manufacturers, will be inclined to minimize the importance of maintaining such conditions of employment as will serve to keep the workmen contented with their lot.

When you take into account the small value of the raw material in the ground required to produce a ton of finished steel, i. e., the ore, coal and limestone, and compare this comparatively insignificant amount with the final total cost of production, you will realize the fact that the great difference is made up of the amounts paid for labor in the various processes from the mine to the consumer. The annual report of the U. S. Steel Corporation for 1909 shows this in a striking manner in the item of annual salaries and wages amounting to $157,063,394.

While it is true that the importance of the attitude of the wage-earner toward his employer has always been recognized, it is only in recent years that the subject has been seriously viewed from any standpoint other than of the wage rates, and that there has come a recognition on the part of the employer of what has been called a "social responsibility."

Much weight has been given, and properly, to the vast resources of ore, coal and stone which form the basis of our industry, and to the necessity for proper conservation of these materials. We are now beginning to place more emphasis than formerly on the human element, which, purely from the economic standpoint and aside from any altruistic motives, must be kept in condition for efficient work if we are to maintain our position in the world markets.

Dr. Eliot, of Harvard says: "Progress is measured by happiness, not by dollars and cents," and no nation can be really progressive unless the great body of its citizen workers are happy and contented.

As an old Carnegie man, you will pardon me if I cite as one of the first notably successful recognitions of the human element as a large factor in successful mill operation, the action of Mr. Carnegie who made it possible for his mill superintendents and other practical operating men who had risen from the rank of ordinary workmen to become his partners. He is credited with having made the statement that if he had lost all of his other assets but had retained his splendid working organization, he could have speedily regained a dominant position in the steel industry. While due allowance must be made for some amiable exaggeration in this declaration, few men who have had any practical experience in the administration of large enterprises will be apt to minimize the importance of the attitude of the workmen to the employer.

How best to weld his employees into a compact and efficient working force is a question constantly in the mind of every intelligent employer.

Prevention of Accidents.

The most striking instance of the aroused interest in the welfare of the workmen is shown in the effort and money which are being expended to safeguard the lives and health of the workmen. I can best illustrate this by a statement of what is being done by the subsidiary companies of the United States Steel Corporation.

These companies now employ about 50 men who devote all or a substantial part of their time to questions affecting the safety and health of employees. The officials in charge of this work estimate that a total expenditure of about $400,000 per year is now and will continue to be required for the maintenance of this organization and for providing safeguards and all sorts of safety devices. These range all the way from the protection of a set screw on a shaft, to the building of subways under tracks for use of workmen. For a statement in greater detail of methods and appliances for the prevention of accidents, you are referred to an article recently published in the "Survey" by David S. Beyer, Chief Safety Inspector of the American Steel & Wire Co.,‡ from which I quote as follows:

> This work is a logical outgrowth of association with the accidents which must inevitably accompany the use of machinery. It is probably safe to say that the "Casualty," or "Accident" Department has always preceded the "Safety" Department; that dealing with the men who have been injured has brought about a desire to prevent the recurrence of accidents. From the first scattering efforts in this direction, have grown more systematic methods until accident prevention has developed such a variety of detail and such breadth of possibilities, that it is fast becoming a technical branch of itself.
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> What was originally a species of self-defense, has broadened out into more humanitarian lines, until at present it is being taken up on a scale that would not have been dreamed of in this country a few years ago. Safeguards once considered entirely satisfactory are being replaced by others of improved construction. New forms of protection are constantly being devised.
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> In some of the companies which were brought together in 1901 to form the U. S. Steel Corporation, organized safety departments have existed for the last fifteen years; in all of them more and more attention has been given to safeguarding employees, until at present each of the main subsidiary companies has a corps of trained specialists who devote their time to studying the causes of accidents and to devising means to prevent them. New impetus was given this work by the interest manifested in it, and the policy adopted toward it by the officials of the Steel Corporation.
>
> Every year all the men in charge of these matters for the several subsidiary companies have been called together at the general offices in New York for discussion of the problems connected with their work, the first general meeting being held in May, 1906.
>
> At these meetings the officers of the Corporation have given assurances of support to the subsidiary companies in every practical undertaking for the prevention of accidents. This resulted in the formation in April, 1908, of a Central Committee of Safety.
>
> This Committee is composed of five members representing subsidiary companies operating the largest plants and mills, with an officer of the U. S. Steel Corporation acting in an advisory capacity. It was empowered to appoint inspectors to examine the various plants and equipment, and submit reports of safety conditions, with suggestions for improvement.
>
> The Committee was further requested to record and disseminate data on regulations, rules, devices, etc., tending toward safer working conditions in the plants.
>
> The Committee has selected as its inspectors men already engaged in safety work in the subsidiary companies; in other words, the matter has resolved itself largely into a system of inter-company inspection, which gives the plants inspected the benefit of new view-point and varied experience, and at the same time enables the inspectors themselves to see what is being done elsewhere, and to carry back new ideas and devices to their own plants.
>
> The plan has worked well and has been of great assistance to the several companies, who hitherto have been coping with their own safety problems without definite knowledge of what other members of the great Corporation family were doing.
>
> Meetings of the Committees are held about once a month, when arrangements for inspection are made, and reports considered. Drawings, photographs, rules, specifications, etc., are submitted for consideration and such as seem desirable are sent out to all companies.

Mr. Crawford, President of the Tennessee Coal, Iron & R. R. Co., has devoted much thought to safety and welfare work among his employees. He writes about an interesting development as follows:

> One of the most important conveniences for the men is bath-houses, which have been installed at the ore mines. There are at present four in use and two are being constructed. They are centrally located at the different divisions on Red Mountain, are built of brick with concrete floors, separate lockers, and wash-rooms for whites and blacks. They are equipped with shower baths and wash-troughs and hot and cold water. They are heated by exhaust steam and are kept clean by attendants in charge night and day. A charge of 50 cts. per month is made for the use of locker and baths. This makes it possible for the men to change their clothes before entering the mine, and on rainy days when they would get wet coming to work, they are able to enter the mine and go to work in dry garments.
>
> Previous to the installation of these "Drys" many men failed to come to work on rainy days. This has not only been a comfort to them, but their health and efficiency have been greatly improved.

Where the question of patent rights is involved, our companies are properly jealous of any attempt on the part of our competitors to infringe, but in this movement to safeguard the lives and health of our workmen, we will be glad to give every one interested the benefit of our experience, and to aid in every possible way to attack this problem of accidents to workmen at the proper end, i. e., by preventing them.

Accident Relief.

In spite of every precaution, large numbers of accidents occur, involving temporary or permanent disability or death.

To meet this condition and secure some measure of uniformity in all the different departments, there has been devised a Voluntary Accident Relief Fund.* This plan of relief is a purely voluntary provision made by the companies for the benefit of employees injured and the families of those killed in the service and constitutes no contract and confers no right of action. The entire amount of money required to carry out the plan will be provided by the company, with no contributions whatsoever from the employes.

The plan provides different compensation for temporary and permanent disablement, based on the nature of the injury, length of service, and number and age of dependents. The present plan is tentative only, but if it meets with success, it is hoped that some similar plan will be permanently adopted.

This question of workmen's compensation is receiving much attention; particularly in those states where large mining and manufacturing industries are located, and the party conventions are bringing it to the front as a political issue by inserting in their platforms planks demanding compulsory compensation laws.

New York and Ohio have within the past year, passed Employers' Liability Laws, and in the States of Wisconsin, Massachusetts, Minnesota, and New Jersey, commissions have recently been appointed by the Legislatures to consider the subject of compensation for industrial injuries.

Under existing liability laws in the various States, only a small proportion of the workmen injured by accidents of their employment, receive anything approaching adequate compensation. The fact that some employers do voluntarily pay their injured workmen even where no legal liability exists, only emphasizes the present chaotic conditions. These conditions are bad enough, even if the questions arising under them were quickly adjusted, but the trouble is intensified and ill feeling engendered between workmen and employers by what is, in my judgment, the great shame of the American people, namely, "The law's delay." In the majority of cases, the very essence of justice is the promptness with which it is administered, but by delays on technicalities, by retrials and appeals to higher courts, the man of limited means is placed at an immense disadvantage. To our shame we must admit that under such conditions the poor man and the rich man or corporation, are not "equal before the law."

I was interested in noticing the language of the oath of office which Mr. Hughes has just taken on his accession to the Supreme Bench. One clause reads: "I will . . . do equal rights to the poor and to the rich."

I believe that our independent legislative and judicial systems are the very bulwarks of our free institutions and I have no sympathy whatever with the recent wanton attacks on our Courts. I would be the last to question the good faith and honesty of purpose of our judges. Nevertheless, the fact remains that judicial procedure in this country must be simplified before such a statement as is contained in this oath becomes a reality in practice.

President Taft has touched on no question more vital to our prosperity than this one of "the law's delay." We need an American Dickens to show forth in their true colors the workings of our circumlocution offices.

The practical certainty of long-drawn-out litigation and the remote prospect of a favorable verdict in many cases, owing to the operation of what many believe to be antiquated "fellow-servant," "contributory-negligence," and "assumption-of-risk" clauses in the various statutes, have helped to foster another evil, namely the so-called "ambulance chaser" who preys upon the credulity of the injured person and undertakes the prosecution of his suit for a contingent fee, often amounting to 50% of the award. Other expenses usually reduce the net amount received to about 30%.

There are great difficulties in the way of framing laws to meet these conditions. The statement has been made that "legislation is the final agency by which the law is brought into harmony with social needs." In other words, legislation, to be effective, must be the crystallization of public opinion.

But even if laws are enacted which reflect public opinion and meet the approval of a majority of employers and workmen, they must run the gauntlet of the courts on the question of their constitutionality. In the event of an adverse decision, legislation must, of course, wait until the tide of public opinion has risen sufficiently to carry amendments to the Federal and State Constitutions.

Personally, I believe that compensation to injured workmen is a legitimate charge against the cost of manufacture and that the victim of an industrial accident or his dependents, should receive compensation, not as an act of grace on the part of his employer but as a right.

The burden of industrial accidents now falls, in the most haphazard and unscientific manner, on the victim himself and his dependents, on the benevolent employer, the sympathetic fellow workman, or the public authorities, or on all of these.

I am inclined to believe that the solution will come eventually by the imposition of a tax on all employers based on the number of employees and the hazards naturally inherent in each industry. The proceeds of this tax should be used, first—to perfect and extend the system of factory and mine inspection so as to prevent accidents and remedy unhealthful conditions of employment; and, second,—to provide an insurance fund from which payments can be made to the injured or their dependents.

How to bring about conditions which will accomplish this on a basis fair to all interests, is, however, a serious problem. My plea to the members of the Institute, most of whom are vitally interested in all of these questions, is to keep an open mind and not to forfeit their influence in shaping legislation by mistaking mere inertia for true conservatism.

United States Steel and Carnegie Pension Fund.

In addition to the Accident Relief Plan, but entirely separate and apart from it in its administration, the United States Steel Corporation has established a fund of $8,000,000 for pension purposes, which, by agreement with Mr. Andrew Carnegie, will be consolidated with the $4,000,000 fund heretofore created by him. The aggregate amount will be known as the "United States Steel and Carnegie Pension Fund"; and the net proceeds will be administered by a board of twelve trustees for the benefit of employees of all subsidiary companies of the United States Steel Corporation. Eight of the trustees

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*A paper read at the first formal meeting of the American Iron and Steel Institute.

†First Vice-President, U. S. Steel Corporation, New York City.

‡See also Engineering News, May 26, 1910, p. 611.—Ed.

*Described in Engineering News, June 9, 1910, p. 676.—Ed.

have been appointed by the Corporation and four by Mr. Carnegie.

It is hoped that the details of administration will be perfected so that the plan will become operative Jan. 1, 1911.

The average American workman does not take kindly to any form of paternalism. There is a wide difference, however, between benevolent schemes which impose restrictions on the liberty of the employees and which may be granted or withheld at the whim of the employer, and such general plans as have been outlined, which so fundamentally affect the lives of the ordinary workmen. These are designed to take into account as a proper element in making up costs of manufacture, accidents to and deterioration of the human element, just as in the case of the inanimate machinery or equipment.

While the altruistic feature seems to be the most prominent, these plans really have a broader basis in the economic fact that the employer cannot reasonably hope to be permanently successful unless his workmen are also prosperous and therefore contented.

The Seven Day Week.

In conclusion, I would like to emphasize again the importance of a question on which it was my privilege to present a paper to the Institute at the dinner following the annual meeting on May 27—namely, the seven-day week in the iron and steel trades. At that time I said:

> As you are aware, the United States Steel Corporation has recently taken some advanced steps in matters vitally affecting the relations between our various companies and their employees, namely: the reduction of seven day labor to a minimum; the establishment of a system of accident and accidental death relief, and the establishment of a pension system.
>
> In considering the first named, i. e., the question of a seven-day-week, we were, of course, met at the outset by the difficulty of adjusting a six-day-week to the operations which are necessarily continuous and which are generally so recognized, even by the most radical opponents of the seven-day-week. This refers particularly to such departments as the blast furnaces. The Corporation has not yet been able to devise a practical working system by which the men employed at these continuous operations can be given one day off in seven, and the purpose of this paper is to invite the cooperation of other companies operating blast furnaces, with a view to devising some workable plan.
>
> It is my own deliberate judgment, after a period of almost thirty years' continuous connection with the industry, the early part of which was passed in manual labor in the mills, that the present conditions which necessitate the employment of the same individual workman twelve hours a day for seven days a week are a reproach to our great industry, and should not in this enlightened age be longer tolerated.

In response to this appeal, a resolution was passed referring the matter to a Committee of five to consider the subject and report later. I understand the Chairman has appointed this Committee, selecting as its members men who have had large practical experience in the handling of blast furnaces and steel works.

President Taft has said:

> The man who does not hope for better things and does not believe that better things can be brought about is not the man likely to bring better things about.
>
> The encouraging sign of the times is that men who believe in better things and who are in position to give effective help in bringing them about, are now taking an active interest in these questions.
>
> The problems confronting us are not easy ones, but they certainly present less difficultis than those which have been surmounted in other lines.
>
> It is not to be expected that men who have been so conspicuously successful in the development of mechanical appliances and processes and in the administration of immense enterprises, will fail to solve these social problems when they are confronted with the absolute necessity for their solution.

Annual Convention of the National Machine Tool Builders Association.

The ninth annual convention of the above association was held at the Astor Hotel, New York City, Oct. 25-26. The two sessions of Oct. 25 were given over to committee meetings, committee reports and routine business. The first session at which papers were read was held on Wednesday morning, Oct. 26. Four papers were presented. The first, by Mr. F. L. Eberhardt, of Newark, N. J., and Mr. C. H. Norton, of Worcester, Mass., was entitled "Who Should Pay the Expenses of a Representative from the Factory when Sent at the Request of the Dealer to Help Close a Deal?" Mr. Henry Hess, of Philadelphia, Pa., then read a paper on "The Use of Ball or Roller Bearings in Machine Tool Construction."

Mr. Hess gave no space to a discussion of types and designs, for which he referred those interested to various papers presented by him before the American Society of Mechanical engineers. He described thrust and radial ball-bearings used on drill presses, milling machines, planers (worm driven), grinding machines, friction feeds, punch presses, cold disk saws, woodworking machinery, shafting and cranes. In spite of the title of his paper, it made no reference to roller bearings. One of the most striking power savings mentioned by Mr. Hess was that on a disk saw run at 4,100 r. p. m. With plain babbitted bearings, a 20-HP. motor was required to drive the saw, and the motor fuses were frequently blown when the load was thrown on. Although these bearings were water jacketed, they had to be renewed about every three weeks. After ball-bearings were installed on this saw, a 7½-HP. motor was found to furnish ample power and the machine had been running for more than a year without any apparent deterioration of the bearings.

The next paper discussed the merits of "Concrete vs. Wood Flooring." The author, Mr. James N. Heald, of Worcester, Mass., presented under this title the replies received to letters sent out to a number of users of concrete and wood flooring in machine shops. The most noticeable objection to concrete floors seemed to come from the workmen in the shops. Machine-tool operators and bench machinists who have to remain standing for long periods without much moving about have a very general dislike for the concrete floor. They say it is more tiring to the feet than the wood floor. There was some difference of opinion as to whether this condition was real or only ascribable to the workman's opposition to the introduction of anything new and unaccustomed.

The theory was advanced that the complaints were really due to the higher heat conductivity of the concrete floor as much as to its more unyielding consistency. Heat was taken from the feet, it was claimed, so fast as to chill them and check the circulation of blood, with consequent discomfort and fatigue to the workman. This theory suggests the remedy of heating the shop by means of steam pipes or hot-air ducts below or embedded in the floor, a system which has been used with success at the plant of the Morse Chain Co., Ithaca, N. Y. (Eng. News, June 16, 1910, p. 695).

It was found, however, that the complaints from workmen ceased if they were given suitable wooden platforms or "pads" of planking to stand on.

There was some difficulty with concrete floors in shops where a lot of heavy trucking was done. The concrete was reported to wear out rapidly under such service. Among the remedies suggested were greater care in laying the concrete, the omission of the marking-off lines on the surface in the aisles where trucking was done and the use of a track of flat steel rails embedded in the floor. In discussing Mr. Heald's paper one of the members told of a machine-shop floor of paving brick which had shown practically no wear under heavy trucking in about five years.

An objection somewhat related to that of wear under trucking was that of dust. In shops where the nature of the work or materials made the presence of dust in the air particularly undesirable, the old maple floor was supposed to give better results.

In a shop with a wooden floor, the accidental dropping of a casting or tool does not generally injure it. With a concrete floor, on the other hand, serious injury to the casting or tool is pretty sure to result. This had occasioned considerable loss in some shops. The only remedy suggested was the training of the workmen to exercise greater care.

Some users of concrete floors found fault with it on the ground that it was not watertight. Inconvenience and damage was caused on lower stories by leakage through the floors above. This fault could hardly occur with well made concrete.

Another objection raised was the greater difficulty of fastening machines to the floor, especially when it was desirable to move a machine from one position to another.

To offset this long list of more or less important objections the concrete floor has some marked advantages over the wood floor. Most important of these is its superiority as a foundation for machine tools. Machines mounted on a concrete floor give much less trouble through vibration. One case was cited where a certain machine could not be used at all satisfactorily on a well-built, heavy wooden floor on account of excessive vibration. When the machine was transferred to a cement floor all trouble from vibration vanished. The cement floor is generally conceded to be easier to keep clean and to wear better under ordinary usage.

Mr. Heald suggested as a most satisfactory floor for machine shops a concrete floor with a surface of maple wood nailed to wooden screeds embedded in the concrete.

The most interesting contribution to the discussion of Mr. Heald's paper was that of Mr. Henry Hess. He described floors built in the Niles tool works in Germany about 15 years ago. The ground floor was of concrete about 12 ins. thick surfaced with creosoted wood paving blocks placed on end. This floor was sufficient as a foundation for the very heaviest machines installed. Mr. Hess called attention to the ease with which this type of floor could be repaired when damaged, for example, by the fall of a heavy casting. The upper floors were of concrete covered with a composition flooring made of sawdust and a mineral binder. This flooring could be obtained in sheets or slabs up to about 6 ins. thick. That used at the Niles works was between ¾ and 1 in. thick. It showed practically no wear after 15 years.

The fourth paper at the Wednesday morning session was read by Mr. Thomas H. Moore, of New York City, Advertising Manager for the John Wanamaker stores. The subject assigned to him was "Advertising: Large Space in Few Papers vs. Small Space in a Number of Papers," but he declared it impossible to give a general rule which would cover all cases. His paper discussed the functions and requirements of a good advertisement.

At the closing session, held on Wednesday afternoon, Mr. C. K. Lassiter, Mechanical Superintendent of the American Locomotive Works, and Mr. John Riddell, of the General Electric Co., Schenectady, N. Y., presented papers on "The Design and Construction of Machine Tools from the User's Standpoint." Mr. Lassiter explained a system used at the American Locomotive Works for watching and improving the operation of the machine tools used and reducing the maintenance charges. It was one man's duty, among other things, to look out for possible improvements in design that could be suggested to the machine tool makers. He explained that where large quantities of similar work are done many of the adjustments and gears on the machine tools can be dispensed with. Much power was ordinarily wasted by a machine tool designed for a wide range of work. He cited one case in particular where a radial drill was specially designed with only one pair of gears, thereby saving, by actual test, several hundred per cent. in the power required for a given cut.

Mr. Riddell made a strong plea for greater simplicity in machine-tool design. He, like Mr. Lassiter, gave particular attention to gearing. He told of a power press on which there was trouble from the repeated breaking of a spur pinion. After trying various other materials, including practically all those ordinarily used for gearing, he had used a pinion built up from pieces of muslin, somewhat in the same way as a rawhide gear. The muslin pinion gave good satisfaction in smoothness of operation and in strength and durability. Mr. Riddell described a test (not yet completed) in which a muslin pinion and a cast, gun-iron pinion were being run in the same gear train under a heavy load as a trial of endurance. His experience seemed to have already shown that muslin pinions were superior to cast-iron in resisting injury from sudden stresses.

Atlantic City was chosen as the place for the next convention. Officers were elected as follows: President, F. A. Geier, Cincinnati, Ohio (re-elected); First Vice-President, C. H. Alvord, Torrington, Conn.; Second Vice-President, C. E. Reck; Treasurer, A. E. Newton; Secretary, C. E. Hildreth, Worcester, Mass.

A STORM WRECKED A FLEET of fishing-boats near Japan, Oct. 11. Reports state that 711 Japanese fishermen were drowned.

A COLLISION between a passenger train and a stock train on the Chicago, Milwaukee & St. Paul Ry., near Miles City, Mont., Oct. 30, killed four persons.

AN EXPLOSION SANK A GUNBOAT off Port de Paix, Haiti, Oct. 25. The boat was the "Liberté" of the Haitian Navy. Reports state that 70 lives were lost.

A CONFLAGRATION AT VICTORIA, B. C., Oct. 26, did damage estimated at about $2,000,000 in the business section of that city. The telephone system was entirely disabled by the fire.

A FIRE in the storage yards of the Atchison, Topeka & Santa Fe Ry., at Topeka, Kan., Oct. 29, destroyed 900 freight cars. The loss is estimated at about $800,000.

A WATER-FRONT FIRE at Superior, Wis., Oct. 25, destroyed the storage shed on the M. A. Hanna coal dock. The shed contained, according to reports, 250,000 tons of anthracite coal. The loss is estimated at $500,000.

SEVERAL FATAL AEROPLANE ACCIDENTS have recently been reported. On Oct. 27, Lieut. Saglietto, of the Italian army, was killed at Centoselle, near Rome, by the overturning of his aeroplane flyer while gliding to earth. On Oct. 26, Fernand Blanchard was killed at Issy, near Paris, France, at the end of a four-hour cross-county flight. His monoplane dropped from a height of 100 ft., through some unexplained cause. On the same day, at Magdeburg, Prussia, Lieut. Monte was killed by the overturning of his Wright biplane flyer. It is reported that he was gliding to earth, and in starting up his motor caused the machine to dive. On Oct. 23, Capt. Madiot, of the French army, was killed during his first practice flight at Douai.

AT AN INTERNATIONAL AVIATION MEET, held at Belmont Park, Long Island, New York City, Oct. 22-31, two new aeroplane records were established. Ralph Johnstone, in a small Wright biplane machine, on Oct. 31, rose to a height of 9,714 ft., some 500 ft. higher than the best previous record. Claude Graham-White, an Englishman, on Oct. 29, won the James Gordon Bennett International Cup for speed record over 100 kilos. (62.1 miles). His time was 61 min. 44-5 sec. During this contest, however, Alfred Leblanc, of France, was making 66 mi. per hr. when his machine was wrecked. Both aviators used Bleroit monoplanes, with forward motors. John B. Moisant, an American, on Oct. 30, also won a special prize of $10,000 for the fastest flight from Belmont Park around the Statue of Liberty in New York Harbor.

AN INTERNATIONAL ENGINEERING AND MACHINERY exhibition is to be held in London during the two weeks from Oct. 4 to 24, 1912. The exhibition is promoted by the "Engineering Review," of London, and the Olympia Exhibition Hall has been secured. The exhibition will be under the direction of Mr. Walter Cawood, of Manchester.

THE PRESSURE TUNNEL UNDER NEW YORK City, designed to carry water from the new Catskill supply (described in Engineering News, Dec. 9, 1909, p. 652; June 2, 1910, p. 655) has been approved by the State Water Supply Commission. This marks the end of the opposition against the portion of the Board of Water Supply's scheme, and work within the city limits can now be legally started at any time.

A LOADED MOTOR TRUCK made a long distance high speed run from Detroit, Mich., to New York City, something over 700 miles. The truck left Detroit on Oct. 18 and reached New York Oct. 22, although the running time was only 52 hrs. and 38 min., showing an average speed of 14 miles per hour. The truck was loaded with 2,000 lbs. of merchandise, its full capacity. It was made by the Grabowsky Power Wagon Co., of Detroit.

THE CAR SURPLUS which has persisted ever since November, 1907, with the exception of the month of October, 1909, has at last disappeared. The American Railway Association's Statistical Bulletin No. 81 shows a total surplus on Oct. 12, 1910, of 33,735 cars. The total shortages on the same date were 20,419 cars, leaving a net surplus of a little over 13,000 cars. Later unofficial reports since this bulletin was issued indicate an increase in the demand for cars which has turned the balance the other way, so that the car surplus may be said to have finally disappeared.

REVISED RATES OF FARE between stations in New Jersey and the new uptown terminal of the Pennsylvania R. R. in New York City show a decided increase over the rates between these same stations and the downtown ferry terminals or the downtown station of the Hudson River tunnels. These new rates cover all stations out as far as New Brunswick (31 miles), and are, from 5 to 14 cts. in excess of the downtown single trip tickets and are uniformly $6.00 in excess of commutation tickets. The fares to the lower stations remain the same as they have previously been. This would seem to indicate that the railroad desires to use the new and magnificent terminal for through traffic only and has taken this means to keep its immense commutation traffic in its old ferry or tunnel routes.

THE VAN BUREN ST. TUNNEL at Chicago, carrying a street railway under the Chicago river, was opened to traffic on Oct. 25. As described in our columns, the three street railway tunnels have had to be lowered to give increased depth for navigation in the river, and the Van Buren st. tunnel is the first to be put in operation. The reconstructed tunnel has approach grades of 11½% on the east side and 7 and 8% on the west side. The tops of the grades are connected to the level tracks by vertical curves of 450 ft. and 600 ft., respectively, while at the bottom they are connected to the level portion of the river tunnel by vertical curves of 1,000 ft. radius. The 11½% grade is steeper than that in either of the other tunnels. The Washington St. tunnel (Engineering News, July 21, 1910) has grades of 9 and 10%. These present maximum grades of approaches leading to the street level will be reduced to 5% and 3% when the approaches are connected with the proposed street railway subway. The reconstruction work was done under the direction of the Board of Supervising Engineers, and in direct charge of Mr. John Z. Murphy, Chief Engineer of the Chicago Railways Co.

TWO TROLLEY WRECKS IN NEW ENGLAND recently echoed faintly the disastrous accidents in Illinois and Indiana. At White Oak, near New Britain, Conn., Oct. 11, a butting collision between two trolley cars caused the death of one man and the injury of about 20 others. The collision occurred on a sharp curve where the view of approaching cars was obscured by a car barn close to the track on the inside of the curve. It appears that Eastern motormen are more courageous than those of the West, or perhaps more securely walled in, for in this case the drivers of both cars had to be chopped out of their crushed vestibules after the accident, whereas in the West it seems customary to escape by jumping.

At Boston, Mass., Oct. 15, a Boston-bound trolley car from Watertown was derailed at a switch at the Boston end of the West Boston bridge over the Charles River. The car swung around and was overturned. Three persons were killed and 25 others were injured.

THE EASTERLY BASIN OF THE JEROME PARK Reservoir, New York City, will probably be carried to completion soon, the sum of $2,200,000 having recently been appropriated for that purpose by the Board of Estimate and Apportionment. The contract for the Jerome Park Reservoir was let to John B. McDonald a number of years ago by the old Aqueduct Commission, but the construction of the easterly basin was discontinued. The westerly basin was built by him after little had been done except excavation work. It is now proposed to complete the easterly basin practically along the lines of the original plans. A draft of the form of contract has been prepared, but owing to various legal formalities it will be several months before the contract will be ready for advertising. Mr. Henry S. Thompson is Commissioner of the Department of Water Supply, Gas and Electricity. Mr. I. de Verona is Chief Engineer of the Department.

A COBALT-CHROMIUM ALLOY.—At the San Francisco meeting of the American Chemical Society, last July, Mr. Elwood Haynes, President of the Haynes Automobile Co., Kokomo, Ind., described researches in the production of alloys of cobalt and nickel with chromium intended primarily for use in contact-type spark plugs for internal-combustion engines. A standard mixture was developed having 75% cobalt and 25% chromium, prepared under special conditions. A tough malleable metal was produced having an elastic limit of 79,000 lbs. per sq. in., a tensile strength of 96,000 lbs., with an elongation of 3%, and a modulus of elasticity of about 30,000,000. By increasing the chromium, sufficient ductility was obtained to enable cold working. The principal property of the new alloy beside the above-mentioned ones is its practical immunity from the attack of oxygen, moisture, acids and alkalies. By mixing this alloy with various other metals, the properties were modified and brittle alloys were obtained which were hard enough to scratch quartz.

COMPRESSED AIR SEWAGE EJECTORS were installed a few years ago in Guildford, England, to raise sewage from low lying areas and permit it to discharge into the basins at the sewage treatment works. There are eight of these ejectors in use with capacities ranging from 50 to 1,200 gals. per min. The compressed air for operating them is furnished by a power station, located adjacent to the town refuse destructor. The waste heat from this destructor generates sufficient steam to drive the air compressors which raise the sewage. The whole system was described in a paper read before the Institution of Municipal and County Engineers at a meeting in Guildford, Oct. 15, the author of the paper being Mr. C. G. Mason, Assoc. M. Inst. C. E., Borough Engineer of Guildford.

Personals.

Mr. J. Walter Bennett, formerly Secretary of the New York City Department of Water Supply, Gas and Electricity, has been made Deputy Commissioner of the same, succeeding Mr. Edward W. Bemis.

Mr. John A. Megrew, Inspector of Maintenance-of-Way of the Delaware & Hudson R. R. at Albany, N. Y., has been appointed Superintendent of the Saratoga and Champlain divisions, with headquarters in the same city.

Mr. C. Eugene Bentley and Mr. S. D. Newton, Assoc. M. Am. Soc. C. E., formerly City Engineer of Knoxville, Tenn., have formed a co-partnership to carry on a general engineering and surveying practice in Jamestown, N. Y.

Mr. Louis L. Johnson, M. Am. Soc. M. E., formerly Gas Engineer, Electrical Department of the Southern Pacific Ry. at San Francisco, Cal., has opened an office as a consulting engineer on gas power and fuels, in the Law Building, Indianapolis, Ind.

Professor A. N. Talbot, M. Am. Soc. C. E., of the College of Engineering of the University of Illinois, has been made a member of the expert commission which is engaged in inspecting and reviewing the work of construction of the new city hall, Chicago, Ill.

Mr. John S. Bleecker, Manager of the Columbus, Ga., street railways, has been elected President of the new Georgia Section of the National Electric Light Association. Mr. Bleecker is a son of Rear-Admiral Bleecker, U. S. N., retired, and a graduate of Massachusetts Institute of Technology in the class of 1898.

Mr. Henry Leighton has been appointed Instructor in Mining Geology and Mineralogy at the University of Pittsburg. Mr. Leighton is a graduate of Cornell University of the class of 1906 and has been an Assistant in Economic Geology in the New York State Museum.

Mr. R. Y. Williams, M. Am. Inst. M. E., will have charge of a specially equipped car which the U. S. Bureau of Mines is to send out for the purpose of instructing mining communities in rescue work. Mr. Williams has been a member of the Illinois State Geological Survey's staff and in charge of its mine rescue work for some time past. A similar car for the Pittsburg district will be in charge of Mr. Charles Enzian, another mining engineer.

Mr. David H. Ray, Jun. M. Am. Soc. C. E., has been appointed Chief Engineer of the Bureau of Buildings for the Borough of Manhattan, New York City. Mr. Ray is a graduate of the College of the City of New York and Columbia University. He has had a variety of experience in railroad construction and building construction work and was for some time an instructor at the College of the City of New York. Mr. Ray obtained his present appointment as the result of a competitive civil service examination.

Mr. Alfred Noble, Past-President, Am. Soc. C. E., has been awarded the John Fritz Medal for 1910, "for his notable achievements as a civil engineer." The presentation will be made at a meeting to be held at the House of the American Society of Civil Engineers on the evening of Wednesday, Nov. 30, 1910, at 8:30 p. m. Dr. Samuel Sheldon, Past-President, Am. Inst. E. E., now President of the Board of Award of the Medal, will preside, and addresses will be made by Mr. Isham Randolph, M. Am. Soc. C. E.; Dr. R. W. Raymond, Secretary, Am. Inst. M. E., and others. The John Fritz Medal was established by the professional associates and friends of Mr. John Fritz, of Bethlehem, Pa., on Aug. 21, 1902, his eightieth birthday, to perpetuate the memory of his achievements in industrial progress. The Medal is awarded by a board of 16, made up in equal numbers from the membership of the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers. It is awarded for notable scientific or industrial achievement, and there is no restriction on account of nationality or sex. Awards of this medal have been made in the past five years to Lord Kelvin, George Westinghouse, Alexander Graham Bell, Thomas Alva Edison and Charles T. Porter.

Obituary.

Peter Gendron, a prominent manufacturer of Toledo, Ohio, died in that city on Oct. 23. Mr. Gendron was chiefly famous for his inventions in connection with steel wheels for bicycles, automobiles and carriages. He had 72 patents on his various inventions.

Dr. Frederick H. Wiggin, one of the most prominent physicians of New York, died on Oct. 28, at Atlantic City, N. J. Dr. Wiggin was born in England in 1853 and was for sometime a student at Rensselaer Polytechnic Institute. However he never practiced engineering.

David Pearce Penhallow, Professor of Botany at McGill University, Montreal, Que., died, Oct. 26, on board the steamship "Lake Manitoba," while en route to Liverpool, England. Prof. Penhallow was one of the oldest members of the University faculty in point of service, having served since 1883.

Col. James Rockwell, who died in Washington, D. C., last week, had been for many years connected with the ordnance department of the army. He graduated from the United States Military Academy in 1870 and since 1874 had been in the ordnance department. He leaves two engineer sons, one J. V. Rockwell, a civil engineer officer in the Navy, and Lieut. Chas. K. Rockwell, Corps of Engineers, U. S. A.

Professor Stillman W. Robinson, M. Am. Soc. M. E., died from heart disease at his home in Columbus, Ohio, on Oct. 31. He was born in Reading, Vt., March 6, 1838. He graduated with the degree of Civil Engineer from the University of Michigan in 1863. From 1863 to '66 he was an assistant engineer on the United States Lake Survey; after which he became Assistant Professor of Geology and Mining at his alma mater; from 1870 to 1878, Professor of Mechanical Engineering and Physics at the University of Illinois; from 1878 to '95, Professor of Mechanical Engineering at Ohio State University, and since then Professor Emeritus.

Prof. Robinson was not only an educator but also was active in the practice of his profession. He was a consulting engineer for the Santa Fe Ry. in 1888 and connected with other engineering enterprises at various times. He was the inventor of many machines, notably some for shoe manufacturing, and as President of the firm of S. W. Robinson & Son, retained the control and management of his numerous patents.

He was the author of several engineering treatises and text-books; notably: "Railroad Economies," published in 1882; "Strength of Wrought Iron Bridge Members" (1882); Compound Steam Pumping Engines" (1884), and "Principles of Mechanism" (1896). He was also a member of the American Society of Civil Engineers, the Society of Naval Architects and Marine Engineers and the Society for the Promotion of Engineering Education.

Engineering Societies.

COMING MEETINGS.

NATIONAL MUNICIPAL LEAGUE.
Nov. 14-18. Annual meeting at Buffalo, N. Y. Secy., C. R. Woodruff, North American Bldg., Philadelphia, Pa.

NATIONAL ASSOCIATION OF RAILWAY COMMISSIONERS.
Nov. 15. Annual meeting at Washington, D. C. Secy., Wm. H. Connelly, Interstate Commerce Commission, Washington, D. C.

AMERICAN RAILWAY ASSOCIATION.
Nov. 16. Semi-annual meeting at St. Louis, Mo. Secy., W. F. Allen, 24 Park Pl., New York City.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
Nov. 17-18. Annual meeting at New York City. Secy., W. J. Baxter, 29 West 39th St., New York City.

NATIONAL SOCIETY FOR THE PROMOTION OF INDUSTRIAL EDUCATION.
Nov. 17-19. Annual convention at Boston, Mass. Secy., James C. Monaghan, 20 West 44th St., New York City.

NEW JERSEY SANITARY ASSOCIATION.
Dec. 2-3. Annual meeting at Lakewood, N. J. Secy., J. A. Exton, 75 Beech St., Arlington, N. J.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.
Dec. 5-6. Annual meeting at New York City. Secy., W. H. Ross, 154 Nassau St., New York City.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Dec. 6-9. Annual meeting at New York City. Secy., C. W. Rice, 29 West 39th St., New York City.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
Dec. 7-9. Annual meeting at New York City. Secy., J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

ASSOCIATION OF AMERICAN PORTLAND CEMENT MANUFCTURERS.
Dec. 12-14. Annual convention at New York City. Secy., Percy H. Wilson, Land Title Bldg., Philadelphia, Pa.

NATIONAL ASSOCIATION OF CEMENT USERS.
Dec. 12-23. Annual convention at New York City. President, Richard L. Humphrey, Harrison Bldg., Philadelphia.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.
Dec. 27. Annual meeting at St. Paul, Minn. Secy., L. O. Howard, Smithsonian Institution, Washington, D. C.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.
Dec. 27-28. Annual meeting at Lafayette, Ind. Secy., E. W. Hamilton, Iowa State College, Ames, Iowa.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
Jan. 2-6. Annual meeting at Winnipeg, Man. Secy., C. H. McLeod, 413 Dorchester St., West, Montreal, Que.

NATIONAL BRICK MANUFACTURERS' ASSOCIATION.—The 25th annual convention will be held at Louisville, Ky., early in February.

AMERICAN CHEMICAL SOCIETY.—The annual meeting will be held in Minneapolis, Minn., Dec. 27-30. The secretary is Mr. Charles L. Parsons, Durham, N. H.

NATIONAL RIVERS AND HARBORS CONGRESS.—The seventh convention is to be held at Washington, D. C., Dec. 7-9, 1910, at the New Willard Hotel. The secretary is Mr. J. F. Ellison, Washington, D. C.

ASSOCIATION OF AMERICAN PORTLAND CEMENT MANUFACTURERS.—At the annual meeting in New York City, Dec. 12-14, the first two days will be reserved for the executive committee meeting and the business meeting of the association. On Dec. 14, there will be an open meeting for the presentation of papers.

AMERICAN RAILWAY ASSOCIATION.—At the meeting in St. Louis, Mo., Nov. 16, reports will be presented from the following committees: Transportation, maintenance, relations between railroads, safe transportation of explosives and other dangerous materials and electrical working.

ENGINEERS CLUB OF ST. LOUIS.—At the regular meeting of Nov. 2, papers were presented on "The Process of Locating the Municipal Bridge," by C. M. Talbert, Assistant to the President of the Board of Public Improvements, and "A Brief Description of the Municipal Bridge," by E. B. Fay, M. Am. Soc. C. E.

AMERICAN ROAD BUILDERS' ASSOCIATION.—The seventh annual convention will be held at Indianapolis, Ind., Dec. 6-9. Papers will be presented on the construction and maintenance of roads and pavements. An exhibition of machinery and materials will be held in connection with the meeting. The secretary is Mr. E. L. Powers, 150 Nassau St., New York City.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.—At the 20th annual meeting, held in Denver, Colo., on Sept. 18 to 20, officers were elected as follows: President, H. Rettinghouse (C. & N. W. Ry.); Treasurer, J. P. Canty (Bos. & Me. Ry.); Secretary, C. A. Lichty, Chicago & Northwestern Ry., Chicago. The next meeting will be held at St. Louis, Mo., in September, 1911.

SANITARY OFFICERS OF NEW YORK STATE.—The tenth annual conference will be held at Buffalo, N. Y., Nov. 16-18, under the auspices of the New York State Department of Health. Six sessions will be held for the reading of papers on public health and sanitation. The third session, on Wednesday evening, Nov. 16, will be open to the public. At this session papers will be read on "The Health Department: Its Supreme Value to the People," by Geo. M. Ward, President of Wells College, Aurora, N. Y., and "Public Health and the Public Purse," by Col. Francis G. Ward, Commissioner of Public Works, Buffalo, N. Y.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—At the meeting in New York City Nov. 2, Mr. C. R. Grimm's paper on "The Arch Principle in Engineering and Esthetic Aspects, and Its Application to Long Spans" was presented for discussion. This paper appeared in the September "Proceedings."

The nominating committee has presented the list of nominees for election at the annual meeting Jan. 18 as follows: For President, Mordecai T. Endicott, Washington, D. C.; for Vice-Presidents, Alfred P. Boller, New York City, and Charles L. Strobel, Chicago, Ill.; for Treasurer, Joseph M. Knap, New York City.

NEW ENGLAND WATER WORKS ASSOCIATION.—The November meeting will be held in Boston, Mass., Nov. 9. A visit will be made in the morning to the yard and shop of the Boston Water Works. In the afternoon, papers will be presented by Mr. Allen Hazen and Mr. Edward S. Cole, both of New York City. Mr. Cole's paper is entitled "Water Consumption and Statistics Relating Thereto."

The nominating committee has presented the following list of nominations for officers to be elected at the annual meeting in January, 1911: For President, Allen Hazen, New York City; for Vice-Presidents, J. Waldo Smith, New York City; Michael F. Collins, Lawrence, Mass.; Irving S. Wood, Providence, R. I.; Frank A. McInnes, Boston, Mass.; Morris Knowles, Pittsburg, Pa.; for Secretary, Willard Kent, Narragansett Pier, R. I.; for Treasurer, Lewis M. Bancroft, Reading, Mass.; for Editor, Richard K. Hale, Boston, Mass.

WESTERN SOCIETY OF ENGINEERS.—At the meeting held at the Society's rooms in Chicago on Oct. 26, a paper was read by Mr. Gordon F. Dodge on "The Use of Diagrams for Solving Engineering Formulas." The author pointed out the increasing use of the graphical system for the representation of information and for the solution of formulas. He showed how common cross-section paper can be adapted to show the relations of three variables, and he considered this method preferable to the use of isometrical diagrams on special isometric paper. Of still greater utility is logarithmic paper, but it is only recently that such paper with graduations greater than 1 to 10 has been carried regularly by dealers. The inability to obtain paper of wider range was stated to account for an apparent unfamiliarity with its use, and more especially for its use in connection with diagrams for formulas involving more than four variables.

THE EDISON MEDAL ASSOCIATION, which was formed by the friends and admirers of Mr. T. A. Edison to found a gold medal in the American Institute of Electrical Engineers, celebrating the invention of the incandescent lamp and 25 years of its successful use, has just closed up its accounts. The Association began its work five years ago and raised a fund of somewhat over $7,600. Mr. James Earle Frazer was engaged to design the medal. The medal was at first to be awarded to students of electrical engineering for thesis work, but this was changed and only one award was made to a student, the amount being $150 without a medal but with a special certificate. Under the new deed of gift the medal is awarded for meritorious achievement in electricity. This year Professor Elihu Thomson was the first recipient.

The officers of the Edison Medal Association engaging in carrying out this work on behalf of the subscribers, and representing them with the Institute and with the Institute Edison Medal Committee, have been Mr. Samuel Insull, President of the Association, Mr. Frank S. Hastings, Treasurer, and Mr. T. C. Martin, Secretary.

NATIONAL MUNICIPAL LEAGUE.—Among the papers to be presented at the meeting in Buffalo, N. Y., Nov. 14-17, are the following: Nov. 14—"The American Genius for Organization, Public and Private," Wm. Allen White, Emporia, Kan.; "Conservation in Municipalities," Wm. Dudley Foulke, Richmond, Ind.; "Patriotism in Municipal Affairs," (presidential address) Charles J. Bonaparte, Baltimore, Md. Nov. 15—"The New Municipal Idea" (secretary's address), Clinton Rogers Woodruff, Philadelphia, Pa.; "City and State Boards of Health and the Proposed Federal Department of Public Health," report from the committee on municipal health and sanitation, by M. N. Baker, chairman, New York City; "Municipal Reference Libraries," committee report, by Horace E. Flack, chairman, Baltimore, Md.; "Present Status of Direct Nominations," Louis M. Greeley, Chicago, Ill.; a number of papers on the franchise question, taking up respectively the League's attitude, the Boston gas settlement, the Boston telephone setlement, Detroit street railway situation, Minneapolis settlement, Kansas City settlement and the Chicago settlement. Nov. 16—'Correlation of General and Municipal Statistics," Wm. F. Willoughby, U. S. Census Bureau; "A Comparison of Commission Forms of Government to Date," Ernest S. Bradford, Washington, D. C. Nov. 17—"An Effective Civil Service Law in Cities," Elliot H. Goodwin, Secy., National Civil Service Reform League.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—The ballot for nominations for officers of the Society to take office at the annual meeting in December has just been issued. The regular Nominating Committee, appointed by the President, is composed of Messrs. Robert W. Hunt, of Chicago, Chairman; George M. Basford, of New York; F. F. Gaines, of Georgia; E. M. Herr, of Pennsylvania, and W. H. V. Rosing, of Missouri. The nominees proposed by this committee are as follows; for President, Dr. Alexander C. Humphreys, President of the firm of Humphreys & Glasgow, New York City and President of the Stevens Institute of Technology; for Vice Presidents, Messrs. H. H. Vaughan, Assistant to Vice President, Canadian Pacific Ry., Montreal; E. M. Herr, First Vice President, Westinghouse Electric & Mfg. Co., Pittsburg; and George M. Brill, Chicago; for Managers, Messrs. D. F. Crawford, General Superintendent of Motive Power, Pennsylvania Lines, Pittsburg; E. B. Katte, Chief Engineer of Electric Traction, N. Y. C. & H. R. R. R., New York City; and Stanley G. Flagg, Jr., Philadelphia; for Treasurer, Hon. William H. Wiley, New York City.

A special nominating committee has also been organized, under the Society's by-law which allows a committee made up of 20 or more voting members of the Society to offer nominations which will have the same standing and be submitted on the same ballot to the voting membership. Among the names on this committee are Messrs. F. B. Allen, Hartford Steam Boiler Co., Horace B. Gale, Chief Engineer, Simplex Electric Heating Co., Cambridge, Mass.; R. E. McKinney, President, Niles-Bement-Pond Co., New York City; J. J. de Kinder, Philadelphia; William H. Bryan, M. L. Holman and J. H. Kinealy, St. Louis. This special committee has nominated for President, Col. E. D. Meier, of New York City, President Heine Safety Boiler Co. It has also nominated Mr. George I. Rockwood, Consulting Engineer, Worcester, for Vice President, and Messrs. C. J. Davidson, Milwaukee, and J. M. Whitham, Philadelphia, for Managers.

The November meeting will be held in New York City Nov. 9, the date having been changed from the customary one so as not to fall on Election Day. Mr. Ellis Soper, of Detroit, Mich., will present a paper on "The Rotary Kiln," in which is discussed the early development of this type of kiln and its use in various industries, particularly the burning of Portland cement. Following this paper, Mr. Charles Whiting Baker, of New York City, will give an illustrated lecture on the Panama Canal. Mr. Baker accompanied President Taft and the board of advisory engineers on a trip to the Canal Zone and is thoroughly familiar with the present status of the canal work.